Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

TECHNOLOGY DEPT.

DECEMBER, 1951

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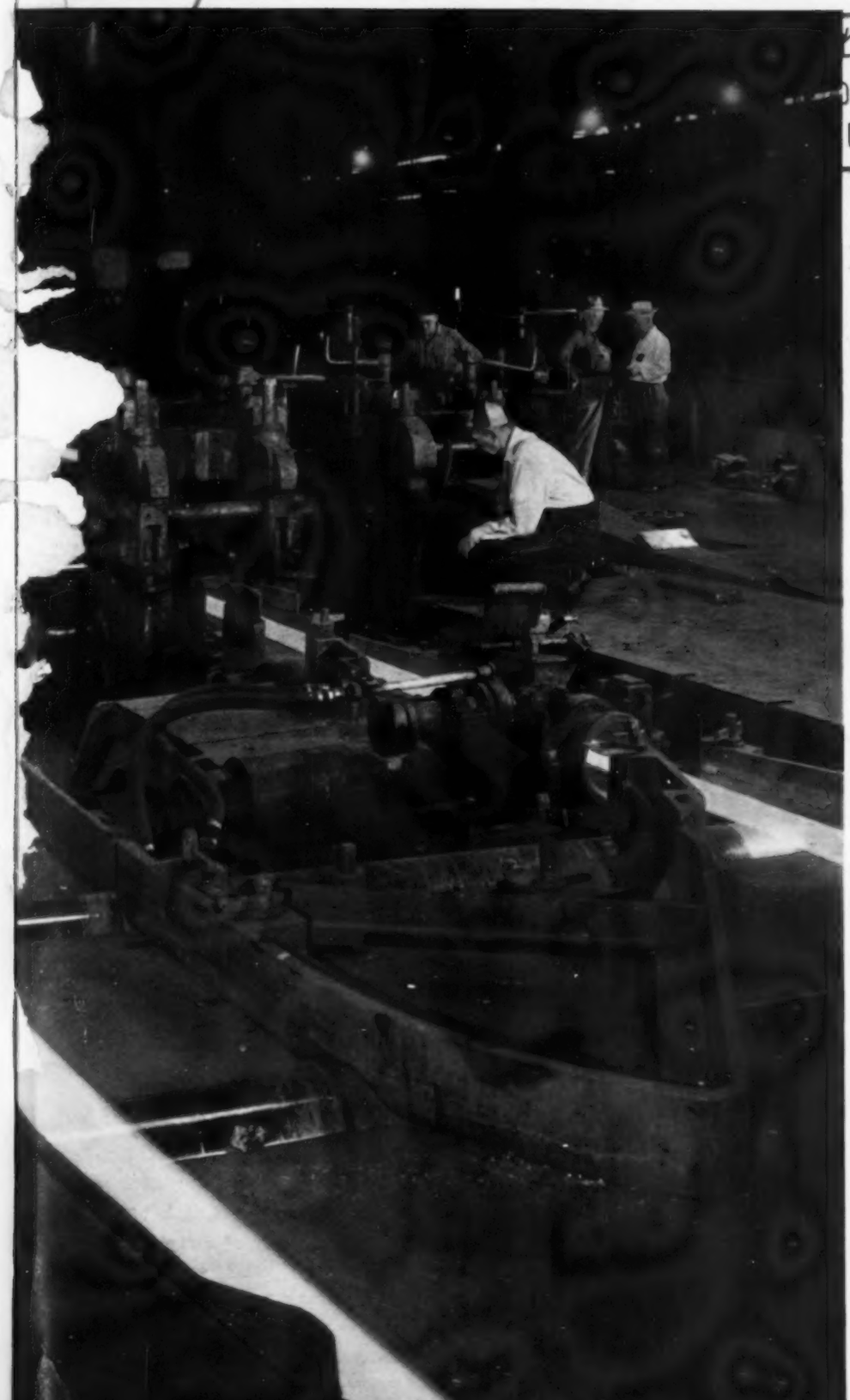

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DETROIT

Continental

Rolling Mill installations engineered complete

BLOOMING MILLS
STRUCTURAL MILLS
BAR MILLS
BILLET MILLS
MERCHANT MILLS
PLATE MILLS
SLABBING MILLS
UNIVERSAL MILLS
HOT STRIP MILLS
COLD STRIP MILLS
NON-FERROUS MILLS

and other steel plant equipment, accessories and special machinery.

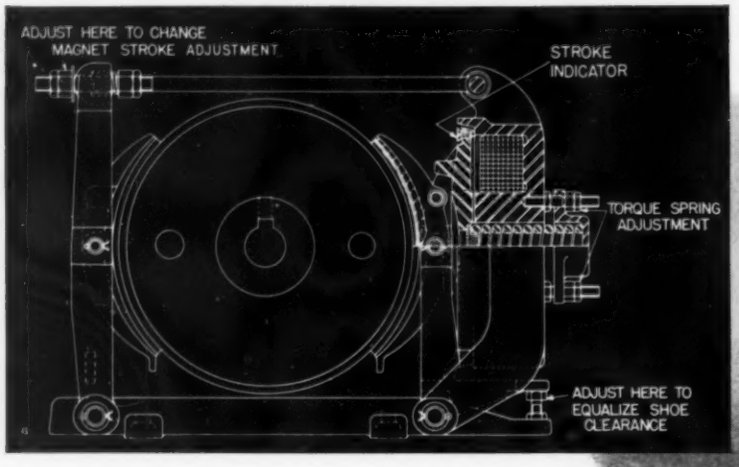
* * *

CASTINGS—carbon and alloy steel from 20 to 250,000 pounds

ROLLS—iron, alloy iron and steel for all types of rolling mills

CHICAGO • PITTSBURGH
Plants at
East Chicago, Ind.
Wheeling, W. Va.
Pittsburgh, Pa.

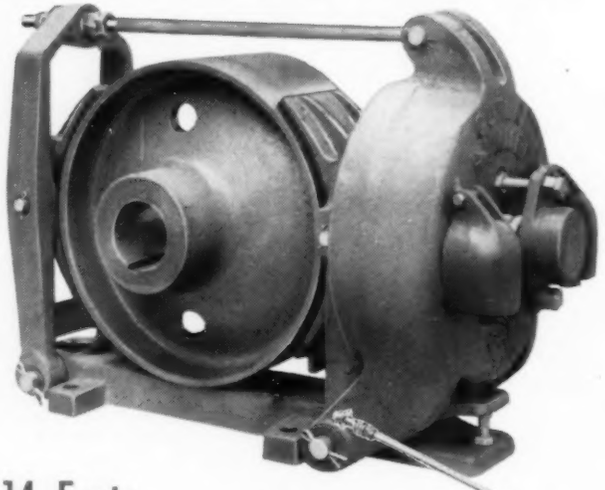
CONTINENTAL
Foundry & Machine
Company

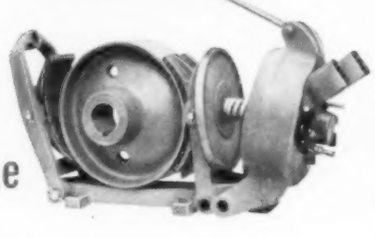

ADJUST HERE TO CHANGE MAGNET STROKE ADJUSTMENT
STROKE INDICATOR
TORQUE SPRING ADJUSTMENT
ADJUST HERE TO EQUALIZE SHOE CLEARANCE

What better Proof?

All attempts to duplicate the performance of the Cutler-Hammer Type M Mill Brake lead to the use of a short stroke direct acting magnet

In the light of the experience of many years, it must be said that when Cutler-Hammer Engineers designed the Type M Mill Duty Brake, they brought out the most nearly ideal solution to the problem of braking action. For any attempts made since then to duplicate its performance lead closer and closer to a duplication of its principle of operation (i.e. short stroke magnet . . . straight line action). Analysis shows that the Type M Brake embodies the simplest and most direct means of achieving braking action. Its structure is very simple and understandable. It employs the fewest parts in its construction. Though sturdy and rugged, it is compact. Braking action is smooth, fast, positive. Linings wear slowly. Only three adjustments are required and are simply made. The Type M Brake is dependable and trouble-free. You can learn more about the design, construction and performance of this brake by writing for Publication BR-2. . . . CUTLER-HAMMER, Inc., 1255 St. Paul Avenue, Milwaukee 1, Wisconsin. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ontario.





14 Facts about Type M Brake

- ✓ Fundamental design proved by years of service in heavy duty applications
- ✓ The simplest of all brakes
- ✓ Has the fewest parts
- ✓ The brake with the fastest action
- ✓ The only brake with one-to-one magnet and total shoe stroke
- ✓ The brake with only 3 simple adjustments
- ✓ Longest service without take-up adjustments
- ✓ Tough long-life lining matched with hard Hammerloy steel wheel
- ✓ Cover-all tubes shield full length of hinge pins against paint, dirt, etc.
- ✓ Renewable hardened hinge pin bushings
- ✓ Hard sheet aluminum magnet coil cover plate caulked in place with aluminum wire
- ✓ Torque spring compression CANNOT be released manually
- ✓ Torque spring fully protected
- ✓ Brass friction plugs keep shoes always aligned

All of these features are also provided, when used on A.C. Service with rectifier

CUTLER-HAMMER
MOTOR CONTROL
C-H

It Set the Pattern Years Ago
It has Set the Pace Ever Since

IRON AND STEEL ENGINEER; published monthly by Association of Iron and Steel Engineers, 1010 Empire Bldg., entered as second class matter January 25, 1924 at Pittsburgh, Pennsylvania, under Act of Congress, March 3, 1879. $7.50 per year in United States and Canada, $10.00 foreign countries. Volume 28, No. 12

Pipe and flat rolled equipment in United States Steel's Fairless Works

Continuous Butt Weld Pipe will be delivered by two mills designed and built by Aetna-Standard. One mill will make sizes ½″ to 1½″. The other mill will make pipe sizes 1¼″ to 4″. Speeds will range from 160 feet per minute for the 4″ size to 1250 feet per minute for the ½″ size. The No. 1 mill will include an Aetna-Standard Rotary Hot Saw. The No. 2 mill will have an Aetna-Standard Reciprocating Hot Saw.

● A large share of the flat rolled finishing equipment in the Fairless Works will be designed and built by Aetna-Standard.

For the cold reduced sheet products, Aetna will engineer and build these lines:

80″ sheet side trimming, slitting and recoiling.

80″ sheet trimming and shearing.

56″ sheet side trimming and shearing.

a sheet stretcher leveller.

These high speed shearing lines will incorporate improved sheet pilers and many other features for high production.

For the Tin Mill Division, the equipment will include a complete Hot Dip Tin House with all auxiliaries; a side trimming and shearing line and a side trimming and recoiling line.

The Hot Dip Tinning equipment will receive the product direct from the tin plate shearing line. Sheet will be fed from packs, electrolytically pickled, coated with tin, cleaned, inspected, assorted and packaged in one operation.

All cut tin plate from the electrolytic tinning line will pass through an Aetna-Standard classifier.

The Fairless Works represents another example of creative engineering by Aetna-Standard, specialists in pipe and tube mills, continuous coating lines, flat rolled equipment, drawbenches and other high production machines.

ASSOCIATED COMPANIES

Head Wrightson Machine Company, Ltd., Middlesbrough, England—Great Britain, Finland, Sweden, Norway, Denmark, Union of South Africa, Northern and Southern Rhodesia.

Aetna-Standard Engineering Company, Ltd., Toronto, Ontario, Canada.

M. Castellvi, Inc., New York, N. Y.—Mexico, Central and South America.

Societe de Constructions de Montbard, Paris, France—France, Belgium, Holland, Luxembourg, Switzerland.

Demag Aktiengesellschaft, Duisburg, Germany—Germany, Austria, Yugoslavia, Greece, Turkey, Egypt.

Compagnia Italiana Forme Acciaio, Milano, Italy—Italy.

Aetna-Japan Company, Ltd., Tokyo, Japan—Japan.

Hale & Kullgren, Inc., Akron, Ohio—Representative for the Rubber Industry.

Designers and Builders to the Ferrous, Non-Ferrous, Leather and Rubber Industries

aetna-standard

THE AETNA-STANDARD ENGINEERING COMPANY • PITTSBURGH, PA.

Plants in Warren, Ohio · Ellwood City, Pennsylvania

. . . makes the finished product better

In modern manufacture, specifications must be met all down the line . . . Fabricators of steel require sheets rolled to their specifications—and an important factor in helping you meet their specifications is the quality of the rolls you specify.

When you specify National Rolls, you are sure of getting rolls that more than meet your requirements for strength, durability and long tonnage life.

THE NATIONAL ROLL & FOUNDRY COMPANY

AVONMORE, PENNSYLVANIA

SPECIALISTS IN IRON AND ALLOY IRON ROLLS AND CASTINGS

assure EXTRA PRODUCTION by giving gears EXTRA PROTECTION

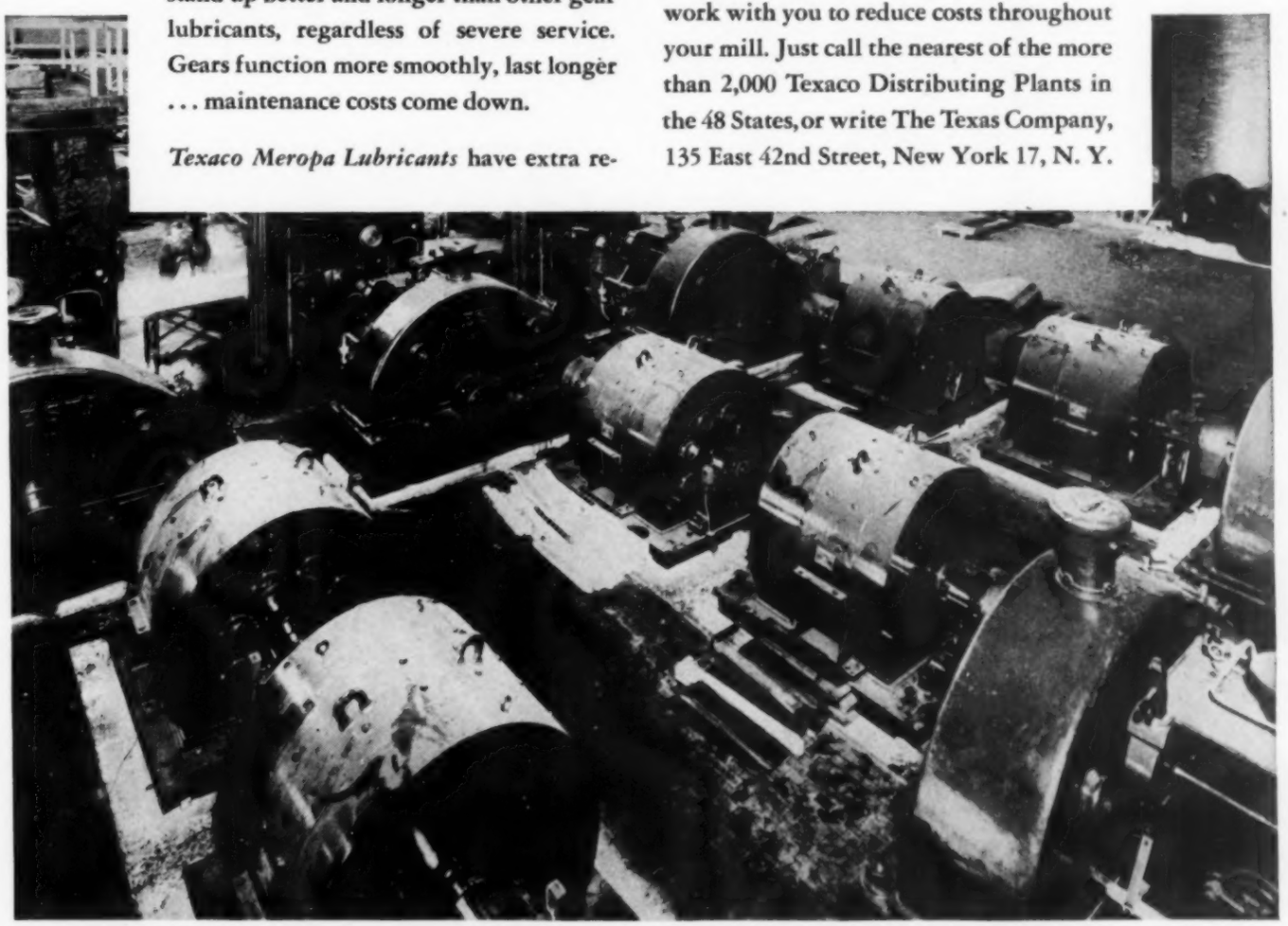
...with Texaco Meropa Lubricant

Present-day production schedules are tough on reduction gears . . . call for a lot of extras. Here's where *Texaco Meropa Lubricant* is used and preferred. Its outstanding EP (extreme pressure) properties stand up better and longer than other gear lubricants, regardless of severe service. Gears function more smoothly, last longer . . . maintenance costs come down.

Texaco Meropa Lubricants have extra resistance to oxidation and thickening. They will not foam . . . will not separate in service, storage or centrifuging . . . protect bearings from corrosion . . . assure extra savings.

For extra protection for oil film roll necks, use *Texaco Regal Oil.* This heavy-duty, turbine-grade oil resists oxidation, emulsification and sludging, keeps systems clean.

A Texaco Lubrication Engineer will gladly work with you to reduce costs throughout your mill. Just call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write The Texas Company, 135 East 42nd Street, New York 17, N. Y.

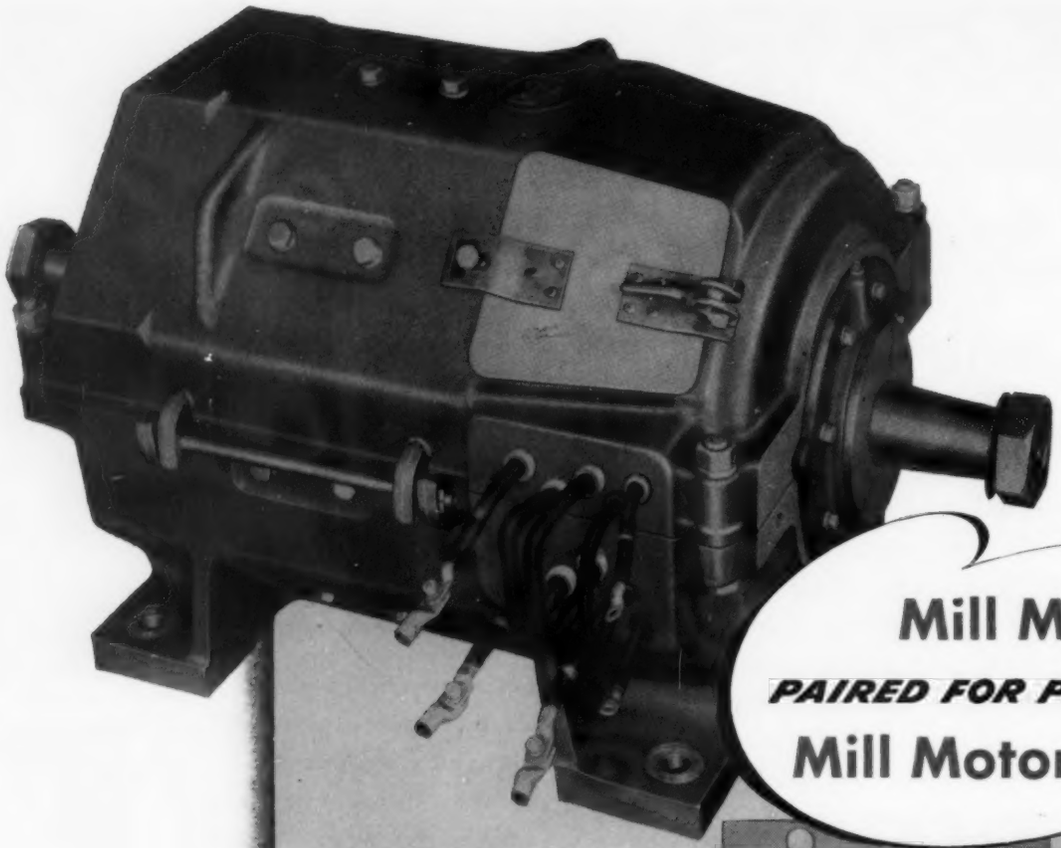


TEXACO

TEXACO Meropa Lubricants

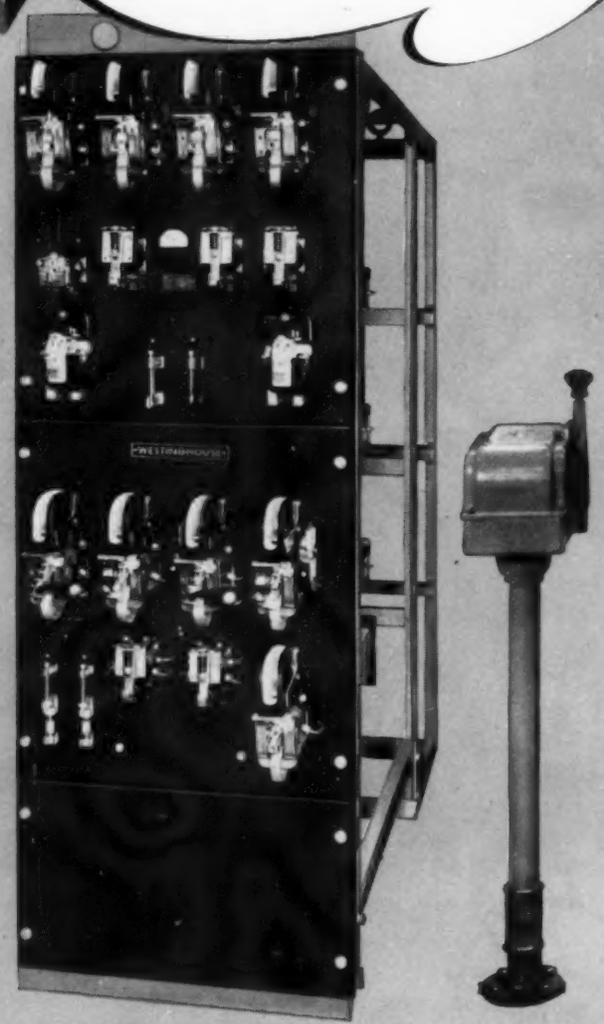
FOR STEEL MILL GEAR DRIVES

TUNE IN . . . TEXACO STAR THEATER starring MILTON BERLE on television every Tuesday night. METROPOLITAN OPERA broadcasts every Saturday afternoon.



Mill Motor
PAIRED FOR PRODUCTION
Mill Motor Control

600 Series Mill Motor



Typical 9500
Line Controller, Type M
Contactors and Type SM
Master Switch

Rugged!

cut mill down time with this team

Certainly in a mill, where down time costs add up fast, the ability of equipment to stand up to rugged continuous duty is of paramount importance. That's why you'll find this combination hard to beat. They are rugged . . . made together to work together. Each incorporates the latest design features to keep production lines rolling.

Take the motor for example. The high starting torque of this new 600 series mill motor is ideal for high inertia loads . . . proved commutation . . . high rated efficiency assures maximum performance under tough service conditions . . . simplified construction makes servicing and maintenance easy. It is a brand-new motor with a new kind of performance built for today's tougher jobs.

Controllers, too, are built to assure new dependability. Main contactors are the new Type M with knife-edge, trouble-free bearings . . . with exclusive Quick-Quench arc boxes which greatly increase contact life. Overload relays are the dual thermal instantaneous type. Accelerating relays are the time-proved inductive time delay Type AZ.

The third part of this control team is the rugged Type SM master switch. Easy to operate, yet with a definite "feel" for each operating point of position, the switches are available with 2 to 6 speed control.

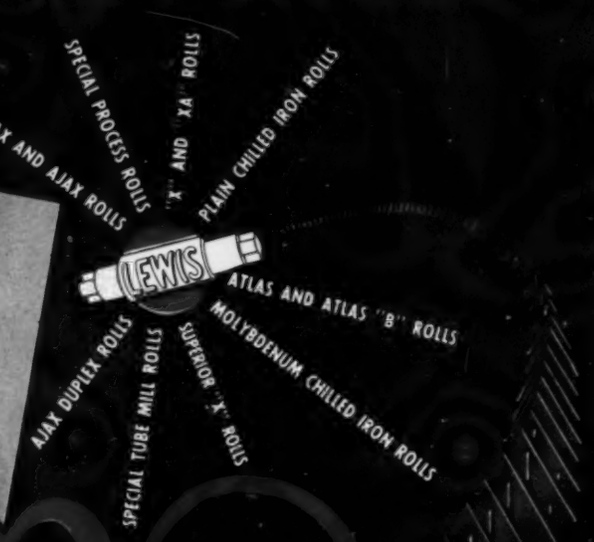
Together, these three offer a new kind of dependability. Get the facts on all three. Ask your nearby Westinghouse representative for a copy of the new booklet B-4730, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-21647

YOU CAN BE SURE.. IF IT'S

Westinghouse

MILL MOTORS AND CONTROLS

Experience gained by over 90 years of Roll making * is marked on all . . .



LEWIS ROLLS

*

THE ROLL MARK OF EXPERIENCE

MANUFACTURERS OF ROLLS AND ROLLING MILL EQUIPMENT FOR THE IRON, STEEL AND NON-FERROUS INDUSTRIES

LEWIS FOUNDRY & MACHINE
DIVISION OF BLAW-KNOX CO.
PITTSBURGH, PENNA.

30% GREATER CONTACT TRAVEL

With NEW KEYSTONE LMI PONY SIZE COLLECTORS

New advantages . . . new economies . . . are now offered with the Keystone LMI Pony Size Collectors! These new collectors are designed for continuous, efficient performance despite severe operating conditions. Outstanding advantages include: improved contact shoe, readily reversible, provides 30% greater contact travel, adds 300% more wearing thickness on each side, lower in overall height.

Solderless throughout, shunt connectors have non-loosening electrical connections. Copper plating on machined surface insures better electrical contact where shunt is connected and prevents corrosion. Maintenance simplified. Only one tool required.

The new Keystone LMI Pony Size Collectors last longer . . . help you reduce inventories and give improved service. For complete information ask for Bulletin 681B. Write today.

OUTSTANDING FEATURES

- **30% greater contact travel**
- **Improved contact shoe**
- **Efficient current transfer**
- **Solderless shunt connectors**
- **Rapid contact reversal**
- **Compensating terminal**
- **Lower overall height**
- **Collector reversible**
- **Easy to maintain**

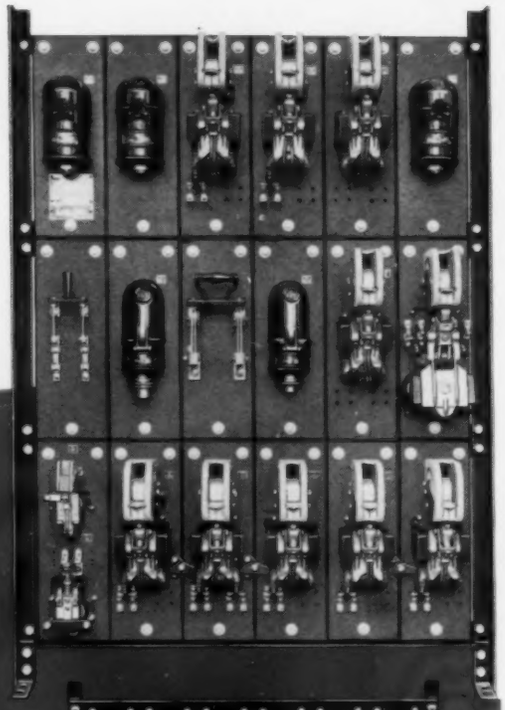
ELECTRIC SERVICE MANUFACTURING CO.

PHILADELPHIA 32, PENNA.

MANUFACTURERS OF COMPLETE LINE OF INSULATOR SUPPORTS FOR RAIL AND WIRE CONDUCTORS AND CURRENT COLLECTION DEVICES.

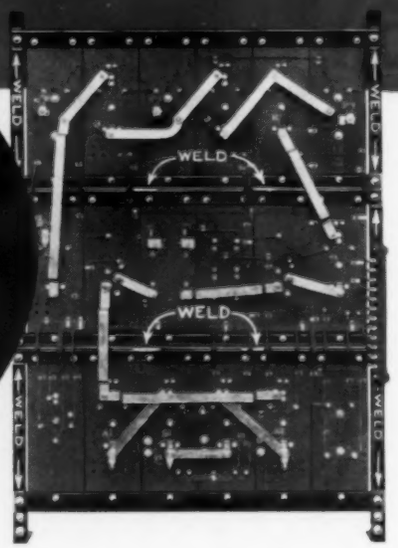
8 *Important Features of* **EC&M** *Magnetic Control*

1. Time-Current Acceleration
2. Line-Arc Contactors
3. Wright Hoist Circuit
4. Tab-Weld Resistors
5. Cam Master Switches
6. Safer Electrical Interlocks
7. Bolted, Welded Frame
8. Quick Contact Renewing

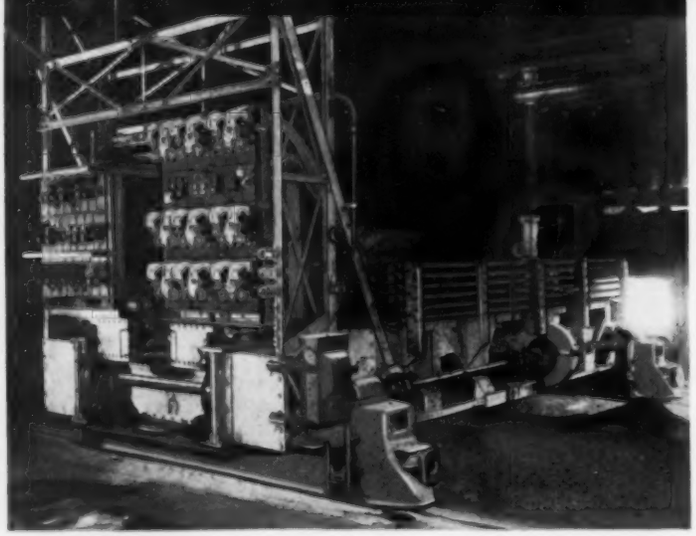


BOLTED and WELDED ANGLE-FRAME *on crane controllers*

The rigidly welded and bolted frame stands up under toughest use.



WHERE SHOCK AND VIBRATION ARE LICKED



EC&M Magnetic Controllers for cranes, ore bridges, charging machines, etc., use individual slate construction for contactors, relays and knife switches, with the slates bolted to the cross-angles of the controller framework.

The vertical and horizontal members of the angle-frame are both bolted and welded to form a strong, rigid assembly which, experience shows, is of major importance in successfully withstanding the shock and vibration of these traveling machines.

Many users report EC&M Controller construction is without equal for use on moving machines. Specify EC&M Control for your next application.

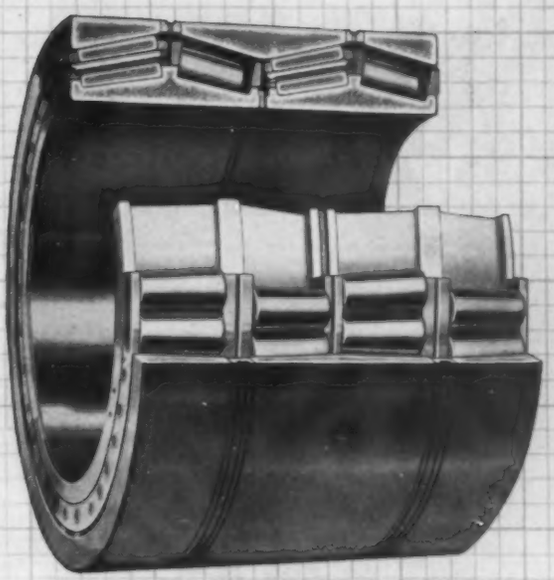
THE ELECTRIC CONTROLLER & MFG. CO.
2698 EAST 79TH STREET • CLEVELAND 4, OHIO

meeting all demands . . .

Torrington Roll Neck Bearings are engineered to sustain maximum production under heavier screw-down pressures and greater speeds.

Four rows of closely-spaced tapered rollers provide tremendous radial and thrust load capacity. Reduced bearing cross-section permits larger roll neck diameters. Low coefficient of friction allows faster acceleration and operation. These advantages all contribute to the production of more and more better quality steel.

Our engineers will welcome the opportunity of working on your friction problems—for rolling mills or other heavy-duty equipment.



THE TORRINGTON COMPANY

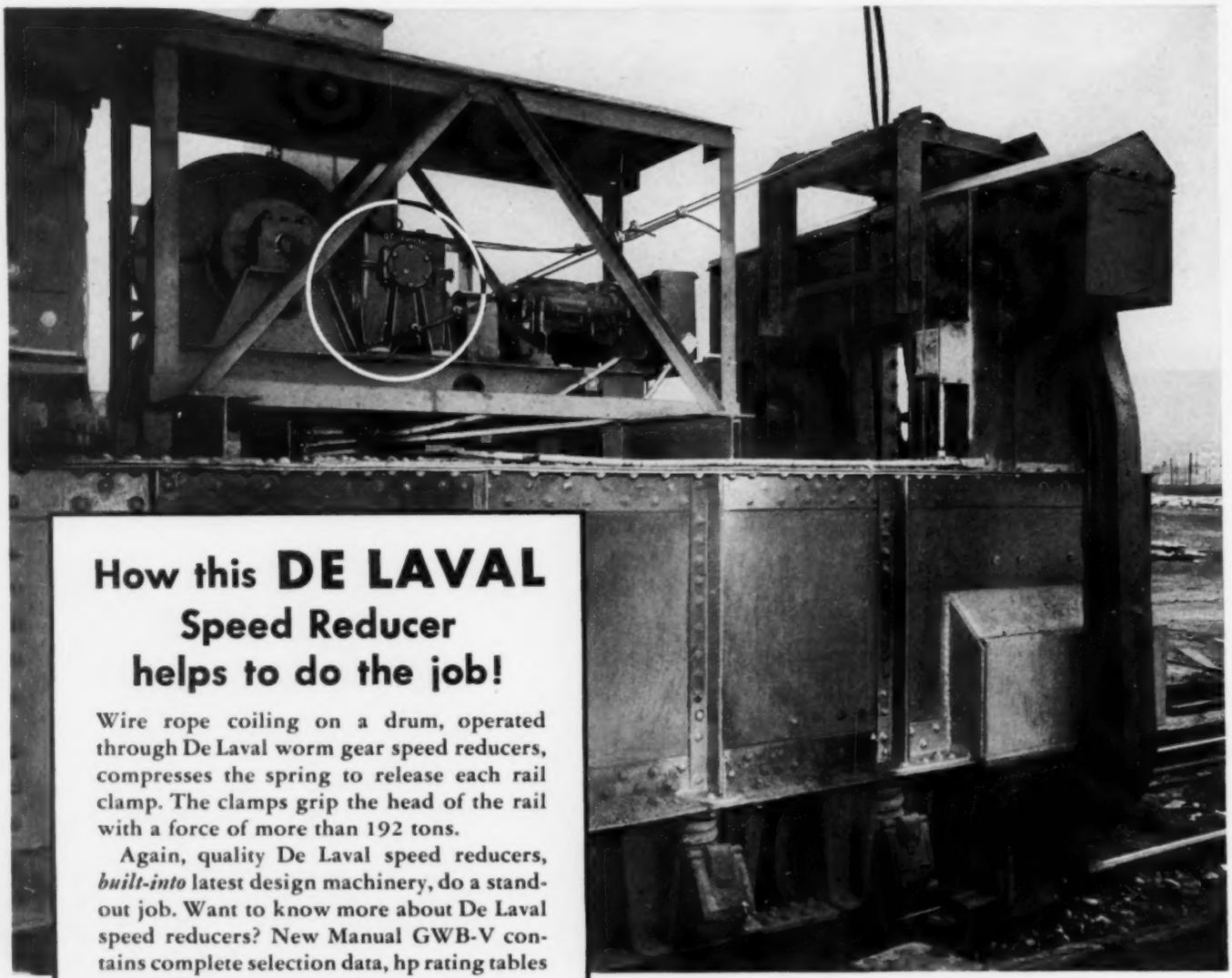
South Bend 21, Ind. • Torrington, Conn.

District Offices and Distributors in Principal Cities of United States and Canada

TORRINGTON *TAPERED ROLLER* **BEARINGS**

SPHERICAL ROLLER • TAPERED ROLLER • STRAIGHT ROLLER • NEEDLE • BALL • NEEDLE ROLLERS

NO Free Ride TODAY!



How this DE LAVAL Speed Reducer helps to do the job!

Wire rope coiling on a drum, operated through De Laval worm gear speed reducers, compresses the spring to release each rail clamp. The clamps grip the head of the rail with a force of more than 192 tons.

Again, quality De Laval speed reducers, *built-into* latest design machinery, do a stand-out job. Want to know more about De Laval speed reducers? New Manual GWB-V contains complete selection data, hp rating tables and outline drawings...all set up in easy-to-use form. Write for your copy today.

50th Anniversary

DE LAVAL *Speed Reducers*

BUILT TO BE BUILT-INTO A QUALITY PRODUCT

DE LAVAL STEAM TURBINE COMPANY • TRENTON 2, NEW JERSEY

Open Hearth Steel Department

Working a heat of high quality steel in the Mesta Open Hearth Department.

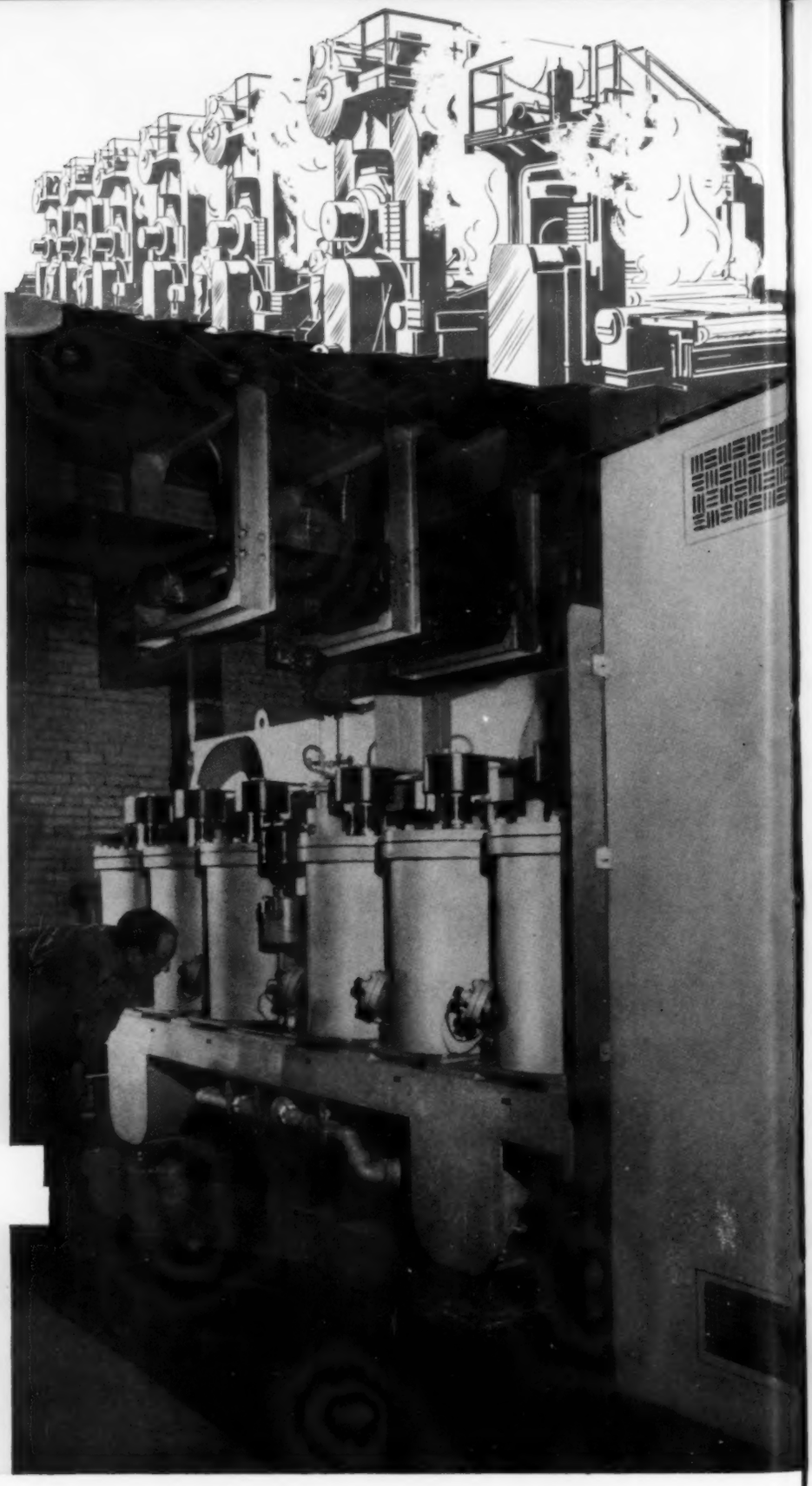
...at

MESTA

Designers and Builders of Complete Steel Plants

MESTA MACHINE COMPANY

PITTSBURGH, PENNSYLVANIA



They did...

This Ignitron unit supplies a hot-strip mill in a big New York plant. When the mill was being planned, the company realized the advantages of the best power supply—in reduced costs, lower maintenance, and increased production.

what...

They called in Westinghouse early in their plans to get the benefit of Westinghouse experience in similar installations.

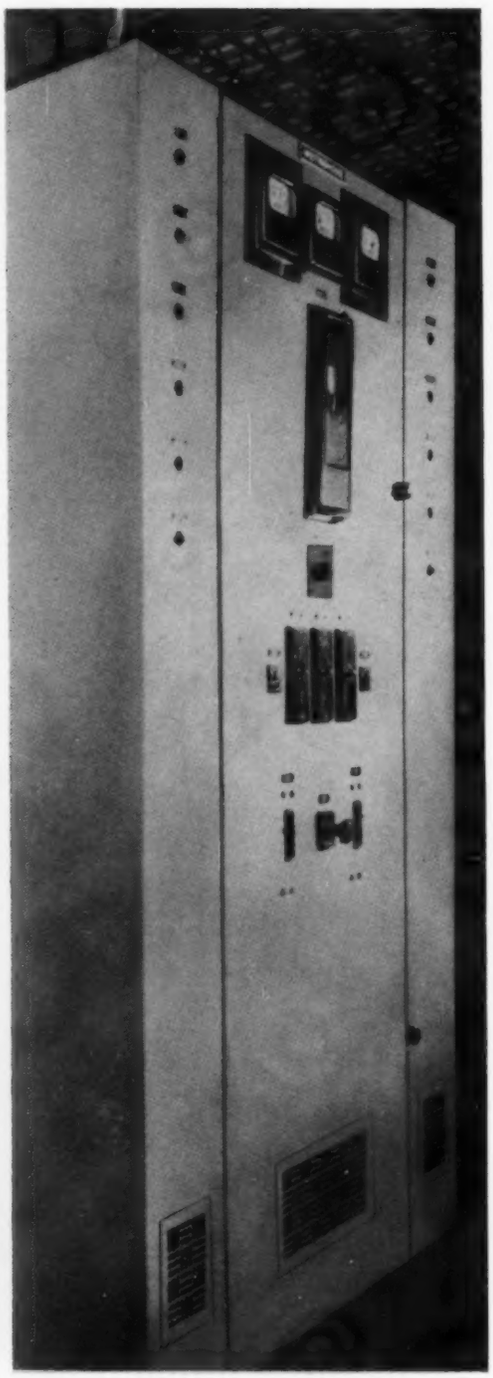
you can do...

Do what scores of other steel firms are doing. Have Westinghouse work with your engineers and machinery builders in applying equipment to your plant.

to produce more

Whether it's a new power system, a mill drive, better servicing, or a piece of electrical equipment to do a tough job ... Westinghouse has the answer.

Here's a new idea for your next rolling mill drive



Westinghouse Ignitrons are a new and proven power source for certain main mill drives. They cut the installed cost, the maintenance cost, and the power bills—for hot strip mills, merchant, rod and bar mills, seamless tube mills. Here's the record of the Ignitrons now in service.

Westinghouse Ignitrons cut costs, save power

Ignitrons cost less than M-G sets, need no special foundations, ventilation or alignment. But the big savings come after they're installed. Ignitrons are considerably more efficient than M-G sets. In the usual hot-strip mill the power saving is 600 kw. This amounts to $36,000 per year on a three-shift operation, figuring power at 1 cent per kwhr.

Excellent operating characteristics

From an operating standpoint, Ignitrons have thoroughly proven their practicality in this service. For starting, the d-c output voltage is reduced by "phase control". Turning a switch brings the mill to full operating speed. The Ignitrons normally supply all the power to the mill, but in two installations they operate in parallel with M-G sets.

Pumped tubes have longest life

Maintenance on Westinghouse Ignitrons averages two-thirds that of M-G sets. A big factor here is the long life of pumped Ignitron tubes. Gases are instantly sucked out by the vacuum system; they can't shorten tube life or necessitate factory overhauls. The vacuum system itself needs about three hours of maintenance once a year.

Call Westinghouse early on EVERY job

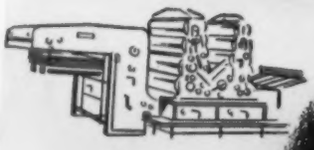
For more information about Ignitron rectifiers get in touch with your Westinghouse representative. And be sure to call in Westinghouse early whenever you're planning *any* new mill capacity. Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pa.

J-94881

YOU CAN BE **SURE**.. IF IT'S

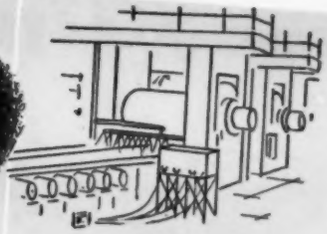
Westinghouse

EQUIPMENT FOR STEEL PRODUCTION

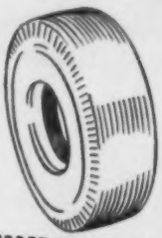


PRINTING INDUSTRY

It's the EXPERIENCE that counts...



STEEL INDUSTRY



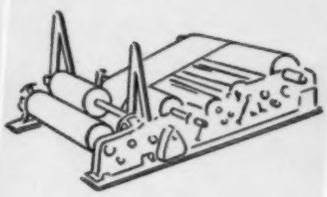
RUBBER INDUSTRY

PLASTICS INDUSTRY

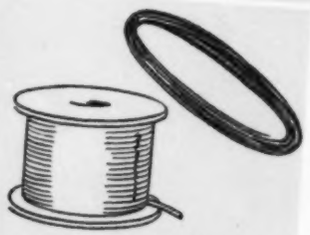
Reliance V★S is the result of nearly 50 years' experience in the engineering and application of Adjustable-speed Drives

FOOD INDUSTRY

V★S Drive provides an unlimited range of speeds from A-c. circuits. In addition, V★S offers controlled acceleration and deceleration; slow speed for jogging, inching or creeping; fast, smooth reversal at any point desired and other specialized functions to suit particular applications. Safe, simplified control saves man hours—reduces operator fatigue. Centralized operator's station for the control of one or more drive motors can be located at any convenient point. Write today for *new* V★S Drive Bulletin D-2311.



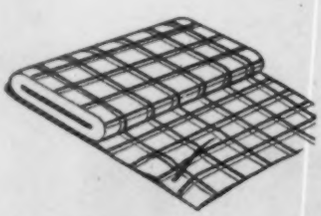
PAPER INDUSTRY



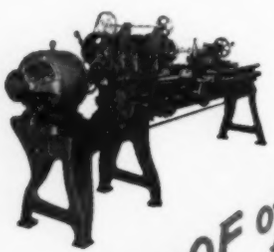
WIRE AND CABLE INDUSTRY

MINING INDUSTRY

CHEMICAL INDUSTRY



TEXTILE INDUSTRY



PROOF of PROGRESS!

Just after the turn of the century, the lathe above made news with its adjustable-speed Reliance Armature-shifting Motor. Modern lathes (right) have built-in Reliance V★S Drives to provide control of all functions of spindle and speeds.

METAL FABRICATING INDUSTRY

RELIANCE ELECTRIC AND ENGINEERING CO.

1084 Ivanhoe Road, Cleveland 10, Ohio • Sales Representatives in Principal Cities

LUBRICATION SYSTEMS
DESIGNED FOR
EACH INDIVIDUAL MILL
De Laval Mill Lubrication Systems are designed for all sizes of mills. For large mills, the lubrication systems are custom-designed. For smaller mills, De Laval offers the Unilube System which is a self-contained unit with circulating capacities of 1 to 40 gallons per minute.
THE DE LAVAL SEPARATOR COMPANY
Poughkeepsie, New York 427 Randolph St., Chicago 6
DE LAVAL SALES & SERVICE, INC.
447 Fourth Ave., Pittsburgh 19
DE LAVAL PACIFIC COMPANY
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DE LAVAL
ENGINEERED SYSTEMS

P&H MILL TYPE CRANES

. . . with all the P&H ADDED VALUES Steel Men want!

Three Gear Case Bridge Drive
delivers motive power to end trucks, perfectly equalized. Mill motor is connected to gear case at center of span, which transmits power equally to the gear cases in front of each end truck.

No Open Gears at Trucks—
gear reductions are completely enclosed in sturdy all-welded cases. All gears run in oil — quietness and long life are insured with all gears operating in oil baths. No exposed gears; no dripping grease.

Flexible Couplings at Wheel Shafts
assure smoother starts — maximum bearing life and prevent thrust from entering gear cases.

Split Gear Cases
are designed to simplify inspection and maintenance.

Large Diameter Cross Shaft
combines maximum strength with low torque to minimize strain.

Hoist Sheaves
readily accessible from trolley deck. All hoist gears, including drum gear and pinion, run in oil.

Trolley Frame
and bridge ends are line bored and milled.

P&H Motors,
brakes and controls are available.

These and many other Added Values explain the preference which accounts for more than 2,000 P&H Cranes in steel mills. P&H Mill Type Cranes are described in Bulletin C-42. Ask for your copy.

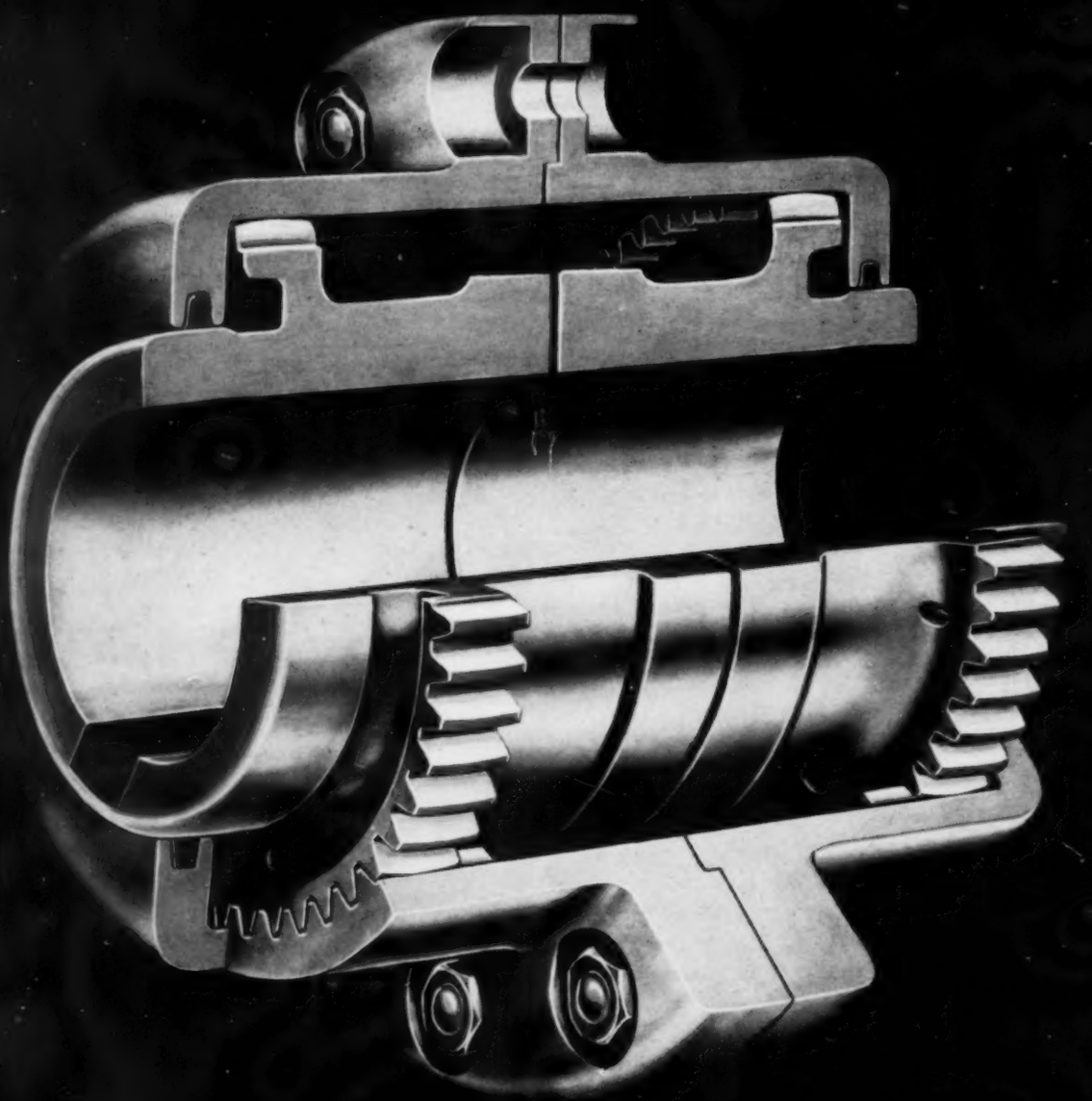
P&H
OVERHEAD CRANES
4455 West National Avenue
Milwaukee 14, Wisconsin
HARNISCHFEGER CORPORATION

POWER SHOVELS • CRAWLER AND TRUCK CRANES • OVERHEAD CRANES • HOISTS • ARC WELDERS AND ELECTRODES • SOIL STABILIZERS • DIESEL ENGINES • PRE-FAB HOMES

UNITED ENGINEERING AND FOUNDRY COMPANY

Pittsburgh, Pa.

POOLE



A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

FLEXIBLE COUPLINGS

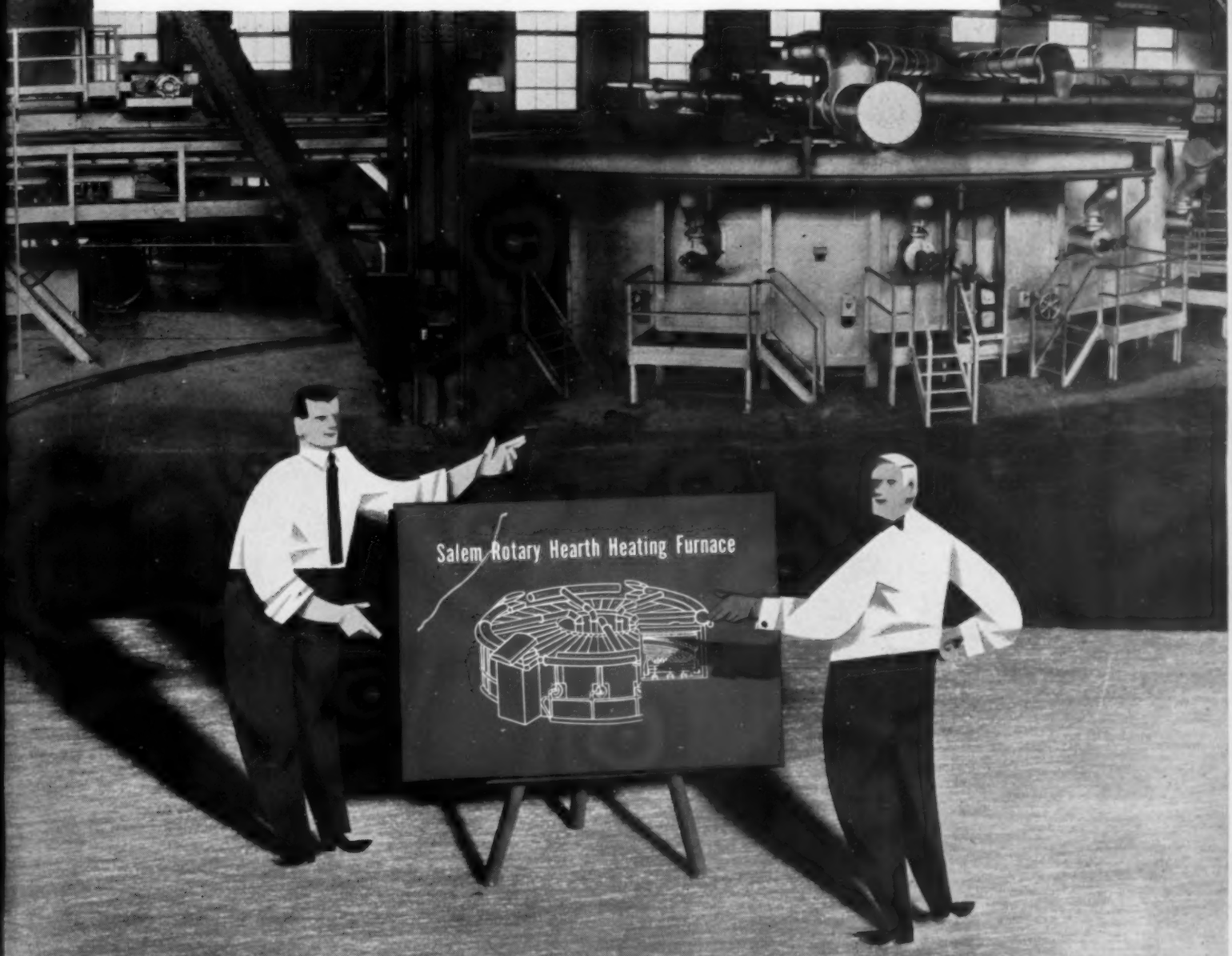
POOLE FOUNDRY & MACHINE COMPANY

WOODBERRY, BALTIMORE, MD.

flexible*

accurate*

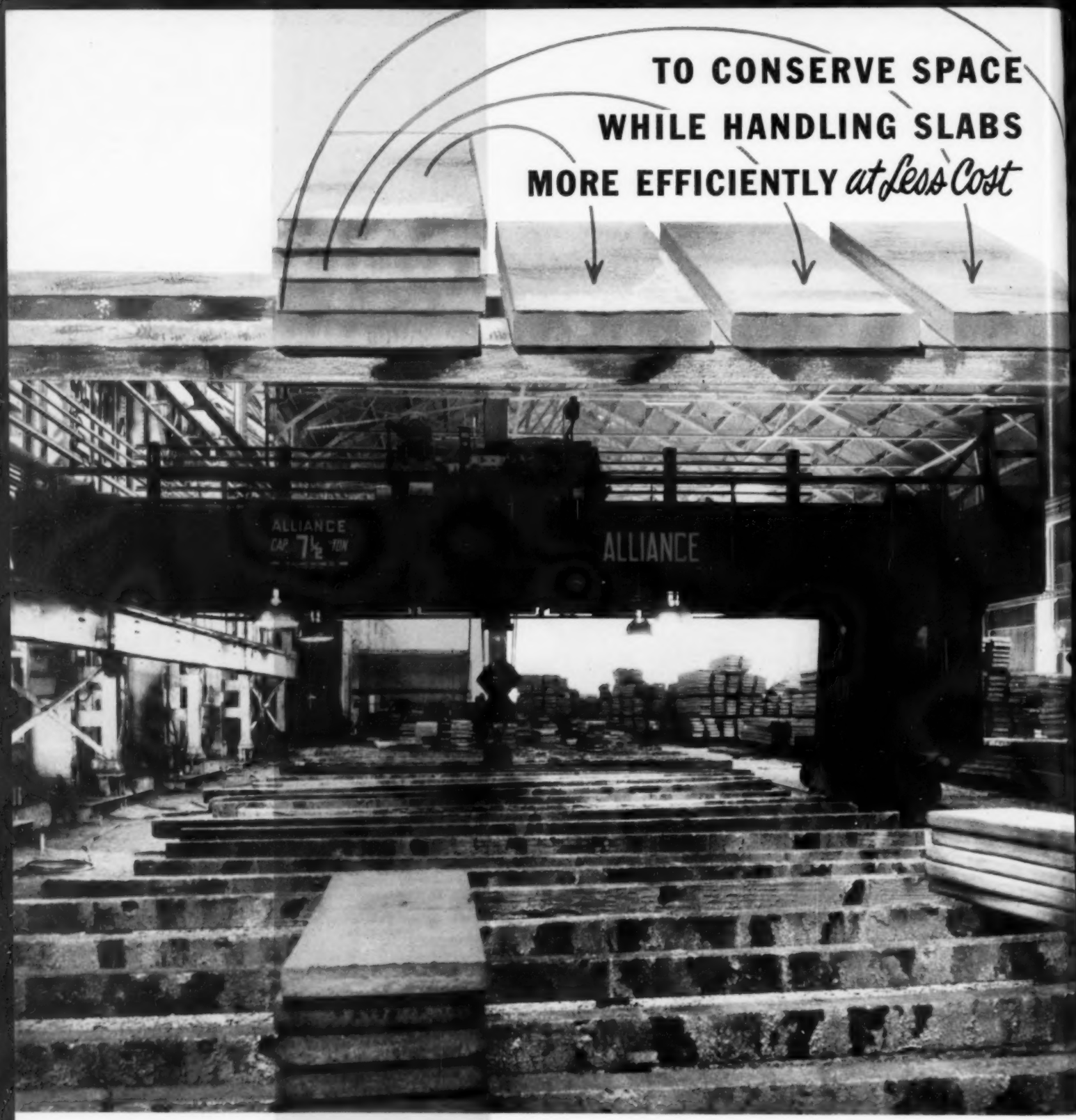
*Two good words to aptly describe the operation of a *Salem Rotary Hearth Heating Furnace* at work in your plant. Whether your hot-metal operations include piercing, forging, or rolling ferrous or non-ferrous metals, your automatically controlled Salem Rotary will flexibly and accurately adapt itself to large variations in heating and tonnage rates —thus maintaining economy despite downtime for changeover in your metal forming operations. Moreover, you'll reduce scale loss, simplify handling, and save money on labor and maintenance. For greater yield at lower cost, you should be using a Salem Rotary. Write to us.



SALEM ENGINEERING DIVISION,

Salem - Brosius, Inc. Salem, Ohio

Affiliates: Brosius Division, Pittsburgh 15, Pa.
Salem Engineering Co., Ltd., Milford nr. Derby, England; Salem Engineering (Canada) Ltd., Toronto, Canada



Alan Wood Steel Company uses *Alliance* telescopic crane

Alliance

LADLE CRANES • GANTRY CRANES • FORGING MANIPULATORS
SOAKING PIT CRANES • STRIPPER CRANES • SLAB AND BILLET
CHARGING MACHINES • OPEN HEARTH CHARGING MACHINES
SPECIAL MILL MACHINERY • STRUCTURAL FABRICATION

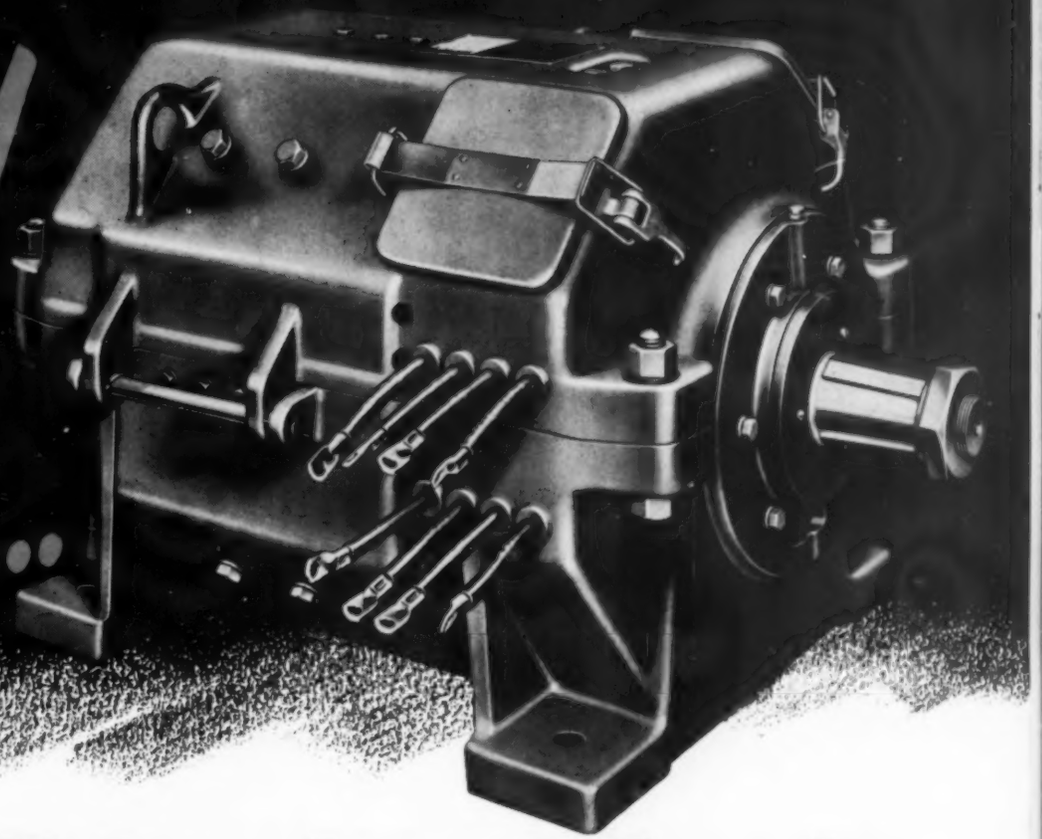
THE ALLIANCE MACHINE COMPANY
Main Office, Alliance, Ohio ★ Pittsburgh Office, 1622 Oliver Building

● Operating underneath the main overhead crane, this newly developed, stiff-leg, semi-gantry, 7½ ton Alliance Slab Handling Crane services the slab storage area of the building as it turns and positions heavy slabs on the scarfing bed.

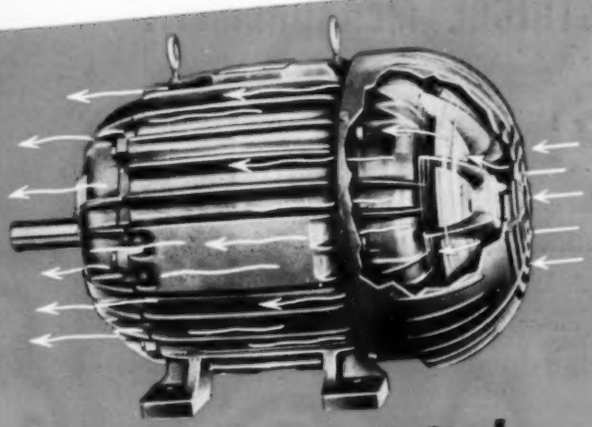
A minimum of headroom is required as this Alliance crane utilizes a special telescopic ram rather than a rack type ram to conserve overhead space. And, because of the compact design, this type crane can be installed where the rack type could not because it requires more headroom. The operator is located on the gantry leg level with his work for perfect visibility.

Alliance, with more than a half-century of crane building experience behind them, is continually developing new ways to give industry added lifting power at reduced costs. Call in your Alliance engineer today for a frank discussion of your heavy material handling problems. Be prepared now and tomorrow.

As rugged as it looks...



ELLIOTT Crocker-Wheeler
600 SERIES MILL MOTOR



Another Tough One!
ELLIOTT CROCKER-WHEELER SEALEDPOWER MOTOR

A totally-enclosed, fan-cooled induction motor that cools and cleans itself by a constant stream of fan-driven air directed along the outside of the finned case. Reliability proved by ten years of successful applications under most trying conditions. In 3 to 125 hp. Also available in vertical type, and in explosion-proof underwriter's approved. Ask for the Sealedpower Bulletin.

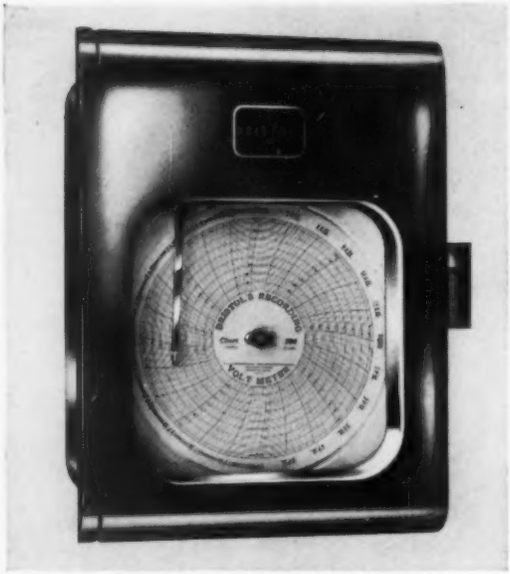
■ Here's a motor than can take the worst that's handed out in heavy duty mill and crane service, and come up smiling. Due to advanced engineering, it packs as much as 1/3 more power in each standard size frame. Rugged cast steel split frame allows quick access to armature, bearings, field coils. From 5 to 265 hp. Also available *separately forced ventilated, protected self-ventilated, back geared.* Write for the Mill Motor Bulletin.

ELLIOTT Company

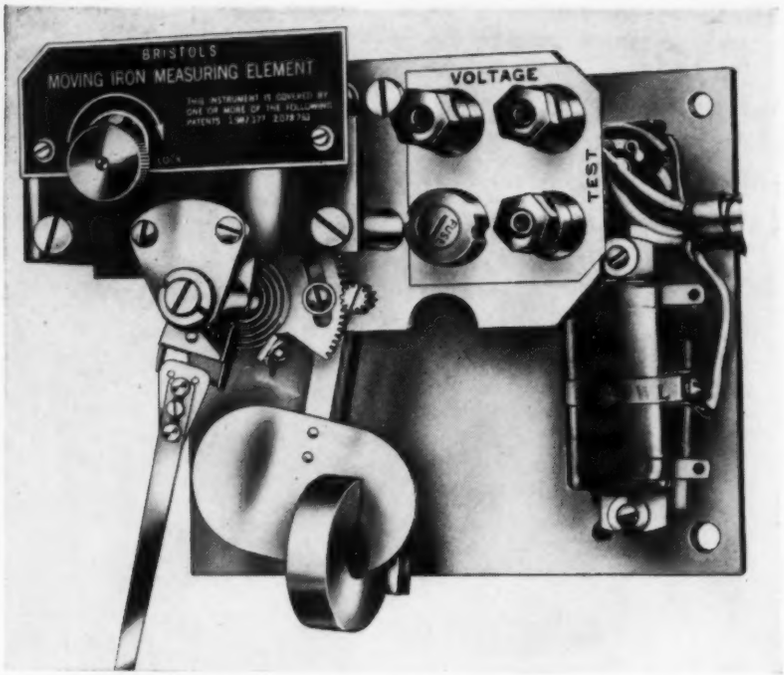
CROCKER-WHEELER DIVISION
AMPERE, N. J.

Plants at: JEANNETTE, PA. ● RIDGWAY, PA. ● AMPERE, N. J.
SPRINGFIELD, O. ● NEWARK, N. J.

BRANCH OFFICES AND REPRESENTATIVES IN PRINCIPAL CITIES
ELLIOTT APPROVED SERVICE SHOPS COVER THE COUNTRY



PERMANENT MOUNTING offered in three models: interchangeable surface and flush, surface-panel and flush panel. Note the pleasing, well-balanced appearance. Also: **PORTABLE INSTRUMENTS** are offered in two models: for setting on floor or table; for mounting on walls or poles and general service.



NEW MOVING-IRON MEASURING MECHANISM. High torque, low burden, rugged construction for assurance that the original calibration will be retained through years of service. Shock-absorbing stainless steel bearings.

NEW RECORDING VOLTMETERS AND AMMETERS ANNOUNCED BY BRISTOL

THE LATEST DEVELOPMENT IN ELECTRICAL MEASUREMENT

Outstanding for—High actuating torque... Low electrical burden... Stability of calibration... Dependable accuracy

Here is electrical measurement at its finest . . . most dependable . . . most convenient to use—the product of nearly 60 years of experience in building recording voltmeters and ammeters for almost every application.

The new moving-iron measuring mechanism is a type known for high actuating torque and low electrical burden . . . refined by Bristol engineers for greater accuracy and ruggedness.

Other Bristol developments that assure convenience in use include the new Series 500 dust- and moisture-protected die-cast aluminum case, quick-set chart hub for easy chart changing, non-obscuring pen lifter, snap-on chart plate.

To keep up with the latest in recording instruments, send for Bulletin E1111, addressing THE BRISTOL COMPANY, 123 Bristol Road, Waterbury 20, Conn.

BRISTOL

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

Price: $.00029 Per Rolled Ton!

How National Bearing Division helps its customers lick costly maintenance problems

If there's one thing tougher than rolling mill service, it's the bronze bearing above. This bearing was completely designed—from the inside out—by National Bearing Division and installed on a trial basis by one of the country's largest steel producers.

Result? Where the service life of bearings previously used averaged just 13 weeks, this bearing ran exactly 16 months and 4 days . . . rolling 1,315,000 tons! Maintenance expenses—including costs of replacement and down-time—were cut right to the bone.

This record-breaking performance was made possible through a special design by National Bearing Division . . . a design involving alloy, bore, grease grooves, babbitt pockets and machining procedure. And, performance of these bearings is so consistently outstanding that the same mill now standardizes on their use.

We're proud of examples like this—because they show how effectively our facilities for Alloy Research and Engineering—combined with 75 years of practical application experience—make money-saving solutions to problems on . . .

Non-Ferrous Bearings and Castings—
As-Cast or Machined

Bronze Bars—
As-Cast or Machined;
Cored, Solid, Hexagon

Babbitt Metals—
For every type of
bearing service

AMERICAN **Brake Shoe** COMPANY

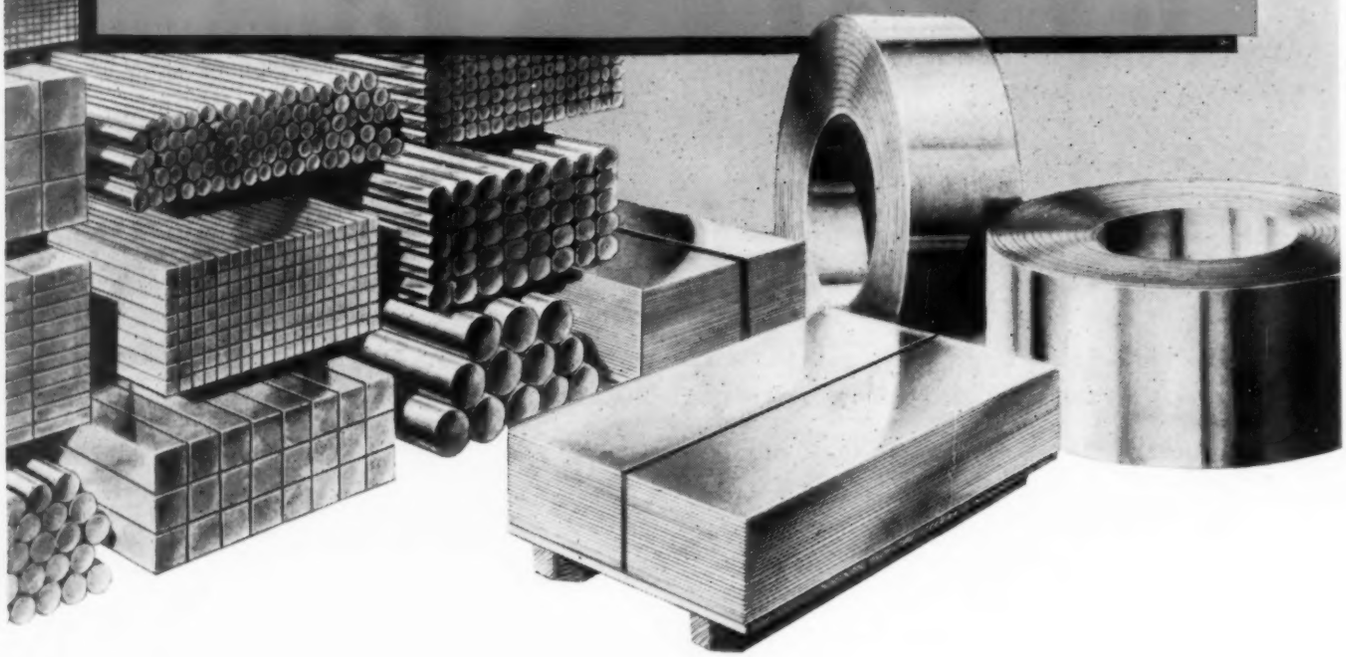
NATIONAL BEARING DIVISION

4936 Manchester Avenue • St. Louis 10, Mo.

PLANTS IN: ST LOUIS, MO • MEADVILLE, PA. • NILES, OHIO • PORTSMOUTH, VA. • ST. PAUL, MINN. • CHICAGO, ILL.

Looking for a better rust preventive for cold rolled products?

Investigate the advantages of Gulf No-Rust



Gulf No-Rust provides positive protection against corrosion for cold rolled steel products under severe conditions of storage and shipment. It is ideal for products exposed to widely fluctuating ambient temperatures and humidities, highly corrosive atmospheres, and outdoor weathering.

Gulf No-Rust is available in several grades; one, an oil-film type that has strong polar characteristics; and several petrolatum-type materials which provide films of varying degrees of toughness. All are easily applied, provide good coverage per unit of volume, and are easily removed by vapor degreasing or by washing with Gulf Stoddard Solvent.

If your customers report cases of surface spoilage due to corrosion, it will pay you to investigate the advantages of Gulf No-Rust. Ask a Gulf Lubrication Engineer for further details. He will fully inform you on the suitability of Gulf No-Rust for various methods of application, types of metal surface, size of product, length of time for which protection is required, conditions of storage or shipment and ease of removal. Write, wire, or phone your nearest Gulf office today. Gulf Oil Corporation · Gulf Refining Company, Gulf Building, Pittsburgh 30, Pennsylvania.

FIFTY YEARS OF SERVICE
1901 GULF 1951
PETROLEUM AND ITS PRODUCTS

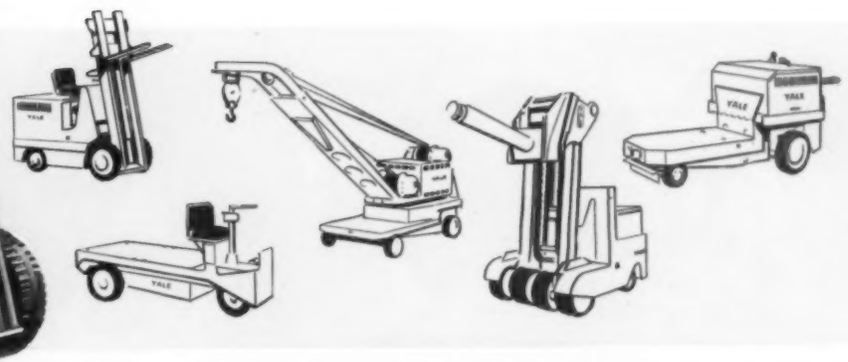
THE BIG 89% PROVES SUPERIORITY OF YALE ELECTRIC TRUCKS

89% of the Yale Electric Trucks sold today are bought by previous users . . . so satisfied with Yale performance and Yale economy that Yale is their choice again.

THESE USERS had ample opportunity to make every on-the-job test—to compare Yale Electric Trucks with any others—to get dollars-and-cents proof of how Yale saves man-hours, steps up production, speeds all materials handling jobs.

These users found Yale Electric Trucks pay for themselves faster...then go on giving many years of service... taking the toughest jobs right in stride.

If you're not already among the users of Yale Electric Trucks, be guided by the Big 89% and this proven record of satisfaction. Ask your Yale Representative to show you the actual performance records which persuade Yale users to buy Yale Electric Trucks again and again.



YALE & TOWNE

The Yale & Towne Manufacturing Co., Philadelphia 15, Pa.

YALE is a registered trade mark of The Yale & Towne Manufacturing Co.

SEND THIS COUPON TODAY

The Yale & Towne Manufacturing Co., Dept. 3412
Roosevelt Boulevard & Haldeman Ave., Philadelphia 15, Pa.

I am interested in cutting my materials handling costs.

☐ Please have your local representative call on me.
☐ Please send me free detailed literature.

Name_____ Title_____

Company_____

Street_____ City_____ State_____

In Canada write: The Yale & Towne Manufacturing Company, St. Catharines, Ontario

YALE GAS AND ELECTRIC INDUSTRIAL TRUCKS • YALE WORKSAVERS • YALE HAND TRUCKS • YALE HAND AND ELECTRIC HOISTS

REDUCE ROLL GRINDING COSTS

$ $ $ $ $ $ $ $ $ $ $

USE FARREL® ROLL GRINDERS

Reports from users indicate that the latest type Farrel machines provide a two-way cost reduction in roll grinding.

1. Rolls can be ground *faster*, which results in lower labor cost per roll ground.

2. Rolls last longer because of the exceptionally smooth and vibration-free action in roll, wheel and traverse drives which means that less metal has to be removed in roughing and finishing operations. This reduces the frequency and cost of roll replacement.

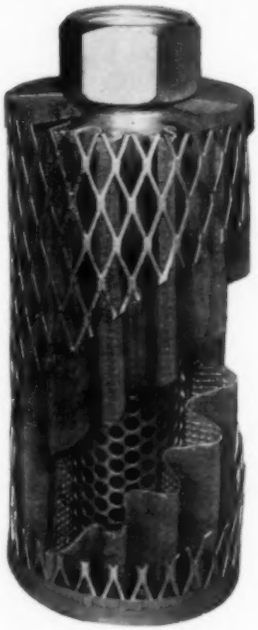
Send for further information about these cost-reducing roll grinders. They are available in two types—type HD shown here, and type TT with traveling work table. Bulletins giving complete specifications of either type will be sent promptly on request.

FARREL-BIRMINGHAM CO., INC., ANSONIA, CONN.

Plants: Ansonia and Derby, Conn., Buffalo, N. Y.
Sales Offices: Ansonia, Buffalo, New York, Pittsburgh, Akron, Chicago, Los Angeles, Houston

FB-715

OVER 250 MANUFACTURERS OF PRODUCTION MACHINES

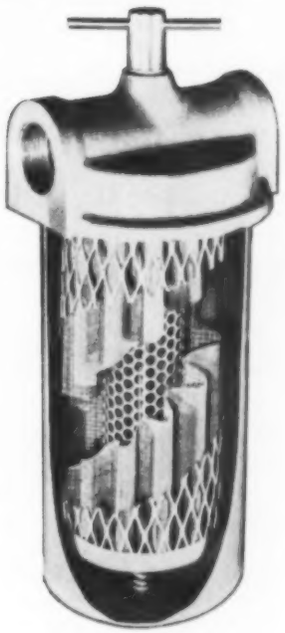


Sump Type (cutaway)

equip
their products
with

MARVEL SYNCLINAL FILTERS

BECAUSE Good Machines Demand Good Protection



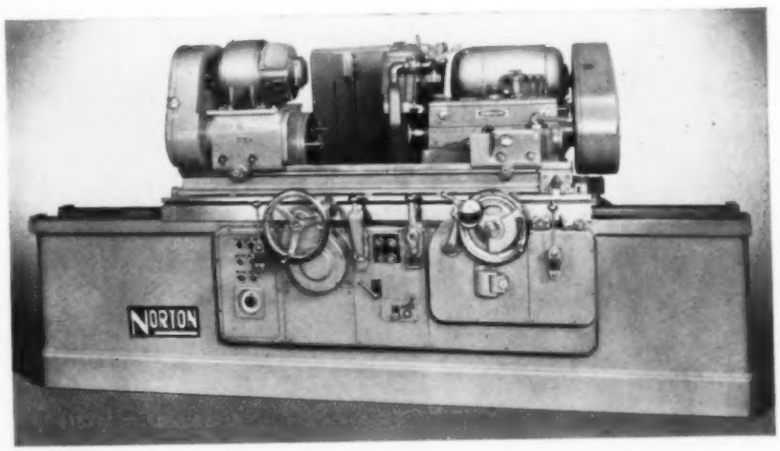
Line Type (cutaway)

FOR ALL HYDRAULIC EQUIPMENT

and low pressure systems using non-corrosive liquids. Marvel's simplicity and ready adaptability make it ideal for standardization within plants, an important feature in every preventive maintenance program. Marvel's efficiency changes down time to producing time.

FIRST COST ONLY COST.

Marvel Synclinal Filters have no moving parts to wear or get out of order. High filtering capacity for space requires less frequent cleanings, and these cleanings, including removal, disassembly and reassembly of the filter, are easily and quickly done by any workman.



NORTON 10" CTU CYLINDRICAL GRINDING MACHINE. "Marvels" do their share in keeping liquids clear of foreign matter in this and other machines produced by the Norton Company. — Photo courtesy Norton Company, Worcester, Mass.

FACTS, NOT CLAIMS

Engineers decide on the basis of record, on the basis of measurable facts rather than on claims of the "campain promise" variety. Here is a fact with meaning: OVER 250 MANUFACTURERS MAKE MARVEL SYNCLINAL FILTERS THEIR O. E. M. CHOICE.

Available in both sump and line type models. Individual capacities from 5 to 100 g.p.m. and mesh sizes from 30 to 200. Multiple installation provides greater capacities as you may require. Line models easily removed without disturbing pipe connections. For efficient cleansing of non-corrosive liquids in all hydraulic and low pressure systems, Marvel has your answer.

Meets
J.I.C.
Standards

Write for Folder 105

MARVEL ENGINEERING COMPANY
625 W. Jackson Blvd. Chicago 6, Ill.

Can you use the "UTILISCOPE?"

The advertisement at the right appeared in BUSINESS WEEK. It has been suggested that this ad contains considerable food for thought for the readers of the IRON & STEEL ENGINEER also. The particular application illustrated here may not interest you but it probably will suggest other uses for the "Utiliscope" in your operations.

If you want to look into the possibilities of the "Utiliscope," simply write us for a copy of Bulletin 1025E which explains the equipment and shows various applications. Please address your request to Department "E."

DIAMOND POWER SPECIALTY CORPORATION

Department "E"

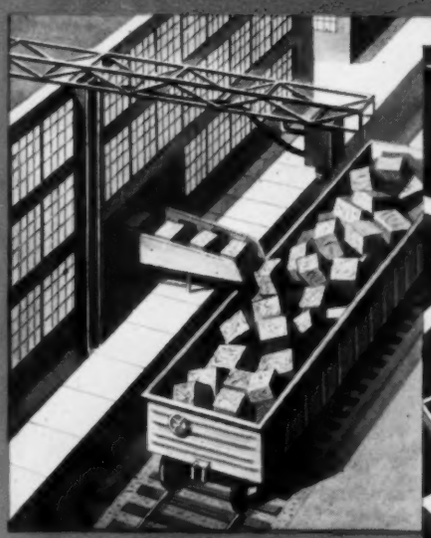
LANCASTER, OHIO

NOW You Can *See* Where You Can't *Look*

DIAMOND "UTILISCOPE"

(WIRED TELEVISION)

Saves Manpower



"Utiliscope" camera watches loading of baled metal scrap into gondola from chute. Man formerly needed here to move car as required for uniform loading.

"Utiliscope" receiver at baler control station shows operator how car is being loaded. He moves gondola by operating car puller from his station.

Here is another operation where the Diamond "Utiliscope" (wired television) saves manpower . . . enables one man to do the work formerly done by two.

The "Utiliscope" extends the power of the eye so you can SEE where you can't LOOK. Obstacles that prevent direct observation (such as danger, building members, discomfort, distance, etc.) are easily overcome by the "Utiliscope."

The "Utiliscope" is surprisingly simple and low in cost. No special skill is needed for installation and operation. Stability and reliability are exceptional . . . the "Utiliscope" is readily adaptable to outdoor mounting.

Let us tell you about numerous operations where the "Utiliscope" is preventing accidents, saving labor, improving product quality and increasing production . . . ask for Bulletin 1025.

TYPICAL USES— Studying destructive tests of engines • Watching flow of molten steel • Checking remote gauge readings • Observing conditions inside furnaces Viewing nuclear research • Coordinating materials flow on conveyors.

The "Utiliscope" (Registered U. S. Patent Office)

DIAMOND POWER SPECIALTY CORP.

FIRST IN INDUSTRIAL TELEVISION

LANCASTER, OHIO • *OFFICES IN 39 PRINCIPAL CITIES*

Diamond Specialty Limited — Windsor, Ontario

Since 1903, Diamond has Manufactured Quality Equipment For Industry

WRITE FOR BULLETIN 1025

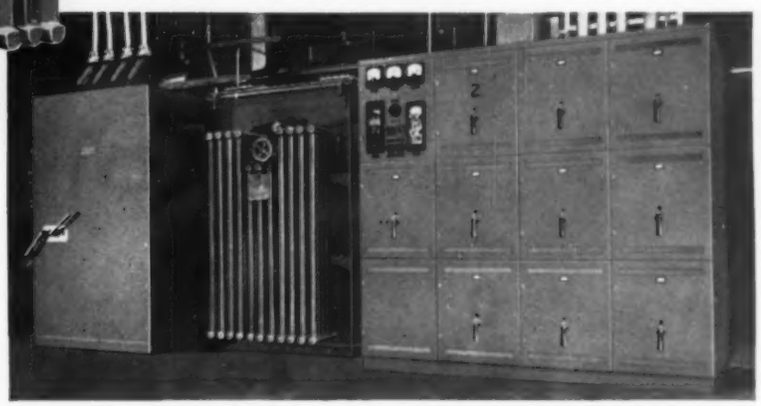
Wagner®
TRANSFORMERS
... the choice of leaders in industry

Wagner
UNIT SUBSTATION TRANSFORMERS

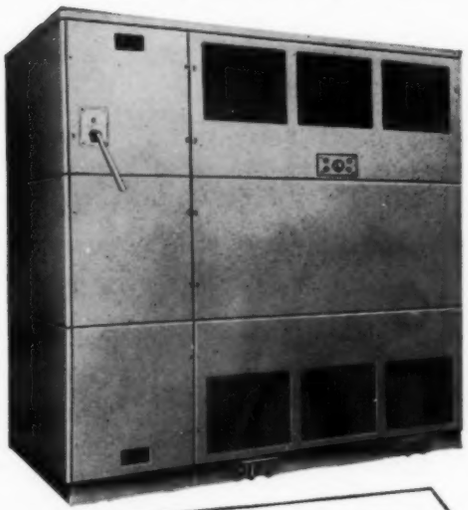
DESIGNED FOR PLANT POWER DISTRIBUTION SYSTEMS

The ever-increasing demand for electric energy to power today's stepped-up production presents a critical problem. The answer to this problem has been found in load-center power distribution systems. The vital part of the load-center system is the transformer. If a switch or circuit breaker fails, only a part of the system is affected—but if the transformer fails, the entire system is dead.

Wagner Unit Substation Transformers assure a continuous, dependable flow of power. They are carefully designed to meet your distribution requirements, and are available with various types of entrances and controls for the high-voltage circuits, and with proper throats on the secondary side to connect to any make of switchgear, in the usual range of ratings up to 2000 kva.



Wagner-equipped unit substation in a synthetic textile plant.



Dry-Type Indoor Transformers

Wagner now furnishes three-phase dry-type transformers in ratings up to 2000 kva in the 15 kv class and below. These units are compactly housed in neat, attractive enclosures, which can be arranged to include primary and secondary switchgear compartments to form readily accessible, closely-coupled unit substations. Relatively light in weight, so that they can be used in multi-story buildings, they are readily adaptable to any installation requirement.

Wagner Electric Corporation
1891 WE 1951

T51-9

WAGNER ELECTRIC CORPORATION
6483 Plymouth Ave., St. Louis 14, Mo., U.S.A.

ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES
AUTOMOTIVE BRAKE SYSTEMS — AIR AND HYDRAULIC

BRANCHES IN 31 PRINCIPAL CITIES

Longer Resistor Life...

FROM Nonbreakable MATERIALS

★ ALL STEEL CONSTRUCTION
★ MICA INSULATION
★ RUGGED TERMINALS
★ PROVISION FOR EXPANSION
★ ADEQUATE VENTILATION
★ UNAFFECTED BY VIBRATION
★ MOISTURE RESISTANT
★ CORROSION PROTECTED

Steel and Mica, the two basic materials entering the construction of P-G Steel Grid Resistors, are the foundation for longer resistor service. P-G uses these materials in a unique design to provide both for expansion and for maximum ventilation. For more detailed information, ask for a copy of Bulletin No. 500 ★ ★ ★ ★ ★ ★

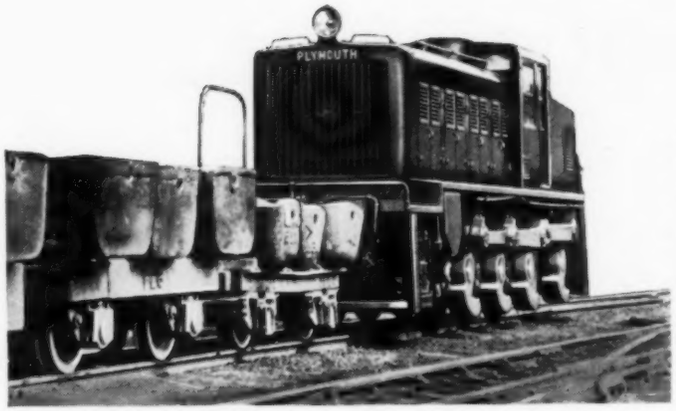
P-G

The Nonbreakable Steel Grid Resistor

THE POST-GLOVER ELECTRIC COMPANY

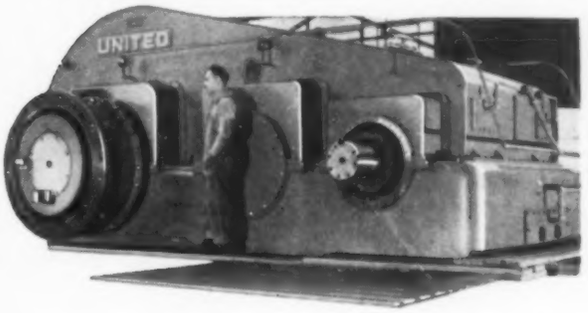
• ESTABLISHED 1892 •

221 WEST THIRD STREET, CINCINNATI 2, OHIO



SKF-equipped Plymouth Locomotive Works Flexomotive.

SKF-equipped United Engineering Company Sheet Mill.



why do so many prefer SKF?

It's pretty hard *not* to buy good bearings today, but SKF is the preferred bearing with many a manufacturer of metal mill equipment.

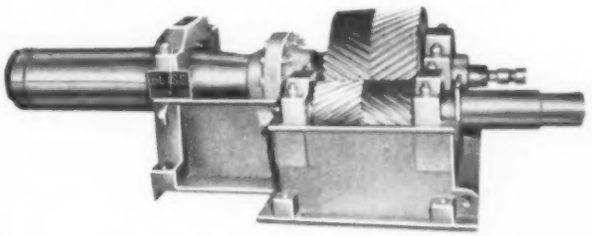
There are good reasons why!

These manufacturers know SKF as a reliable, friendly supplier. They've learned to have implicit confidence in the experienced bearing engineering specialists at SKF's headquarters. They appreciate the teamwork of SKF field men who are qualified specialists in the application of bearings to metal mill equipment.

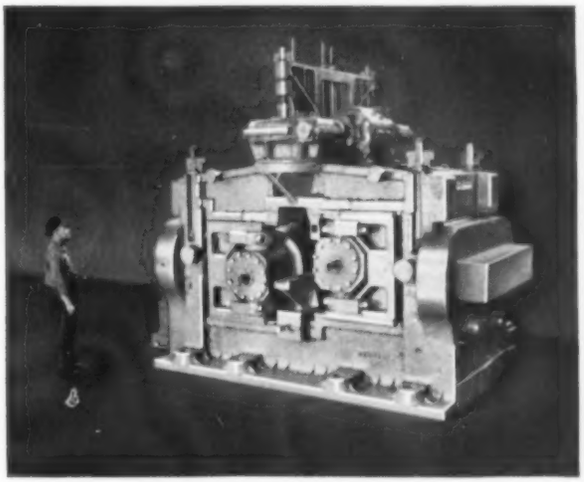
Their customers know the value of the complete maintenance service available to them through SKF's Distributor Organization.

Whatever your product, your engineers and designers can have this helpful SKF teamwork simply by asking for it. 7285

SKF-equipped E. W. Bliss Company Tension Reel.



SKF-equipped Aetna-Standard Engineering Company Reeling Machine.



SKF
BALL AND ROLLER BEARINGS

8 REASONS WHY **SKF** IS PREFERRED BY ALL INDUSTRY

integrity • craftsmanship • metallurgy
tolerance control • surface finish
product uniformity • engineering service
field service

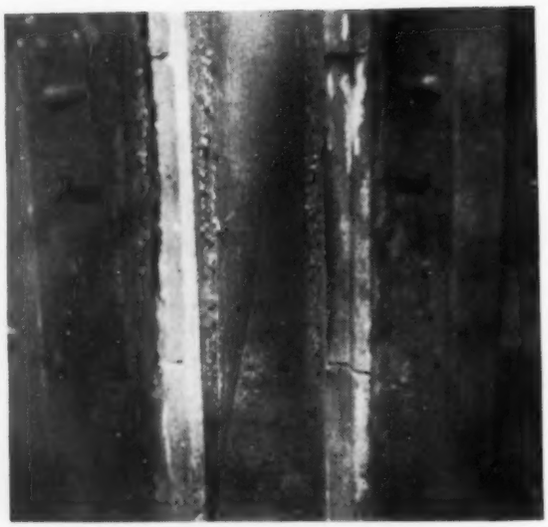
SKF INDUSTRIES, INC., PHILADELPHIA 32, PA.—*manufacturers of* **SKF** *and* HESS-BRIGHT *bearings.*

No Refractory Cement Ever Like It for Bonding or Patching

the Brickwork in Linings, Settings, Floors, Doors, Arches, Baffles, Jambs

in Coke Ovens, Blast Furnaces, Soaking Pits, Forge Furnaces Reheating and Annealing Furnaces, Cupolas, Boilers

R&I SUPER #3000 Refractory Cement



This coke oven floor was repaired, while still hot, with Super #3000, without expensive labor or having to cool down the oven. Using Super #3000 has saved the coke plant $10,000 in a short time.

✓ Sets Harder
✓ Bonds Stronger
✓ Lasts Longer Under Severe Service at High or Low Temperatures

Super #3000 is a ready mixed, plastic mortar for laying new refractories, patching, or wash-coating refractories for added protection.

Made to withstand any working temperature to 3000° F., flame erosion and abrasion, Super #3000 is matchless for adhesiveness and durability. It does not crack or break, and definitely reduces spalling.

Super #3000 is easy to mix and apply. It air sets quickly to flint-like hardness and makes joints that outlast the refractories it bonds.

Where service is severe, where repairs are frequent, you can reduce your maintenance troubles and expense by bonding or patching with Super #3000.

Use the best. Use Super #3000 Refractory Cement. Write for full details.

REFRACTORY & INSULATION CORP.

R&I Bonding and Castable Cements • Insulating Block, Blankets and Cements

126 WALL STREET • NEW YORK 5, N. Y.

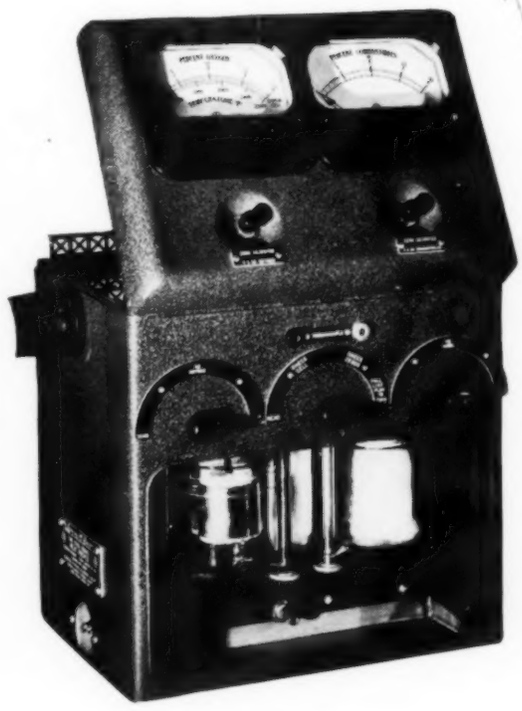
Offices in Chicago — Philadelphia — Cleveland — Newark, N. J.

Mobilizing BTU's

Now that the "heat's on" for record production, the calls are increasing for the services of the Cities Service Heat Prover. This scientific instrument gives an accurate, instantaneous and continuous picture of combustion conditions in all types of furnaces.

You'll readily be able to calculate any oxygen excess, waste combustible matter, and potential fuel savings. The results are like an accurate "diagram" of corrective measures needed to conserve heat units for consistently higher production at lower cost.

You'll see profit in applying the Cities Service Heat Prover . . . *not an instrument you buy, but a service we supply!* Call or write your local Cities Service office about arrangements. Or simply return the coupon today.



THE COMPLETE CITIES SERVICE LINE FOR THE METAL FABRICATING INDUSTRY INCLUDES

Chillo Cutting Oils • Trojan Greases • Trojan Gear Oils
Pacemaker T Hydraulic Oils • Optimus Cylinder Oils
Q-T (Quenching and Tempering) Oils

CITIES SERVICE OIL CO.
Sixty Wall Tower, Room 250
New York 5, N. Y.

Without obligation please send your booklet, "Combustion Control for Industry."

Name_____
Company_____
Address_____
City and State_____

CITIES SERVICE
QUALITY PETROLEUM PRODUCTS

Joe Humenik began his career at Okonite in 1911. Today, his 40 years of skill are part of the vast know-how which goes into every cable. Here, he is applying a braided cover to a 60,000 volt shock-proof X-ray cable developed at Okonite.

• • •

Joe's son Ed, one of the many second generation employees at Okonite, joined the company in 1940, served 4 years in the Navy, now inspects and packages Okonite's famed Manson friction tape.

THAT ELUSIVE "Something"

Pride in a job well done is all too rare these days. Yet pride in workmanship puts something into a product that neither machine nor material can contribute.

That elusive "something" is an integral part of every Okonite cable. Added to Okonite's premium materials and advanced manufacturing techniques, it spreads the extra margin of quality that tips the balance between a cable that's superior and one that is merely good enough.

Meticulous care in the making of insulated cables contributes heavily to the performance of vital electrical circuits. It has helped to make Okonite cables the outstanding choice for reliability among leading utilities, railroads and heavy industries.

This craftsman's pride in his work is shared by countless Okonite employees. Better than one out of every six have worked here 20 years or more. Many are second, even third generation employees.

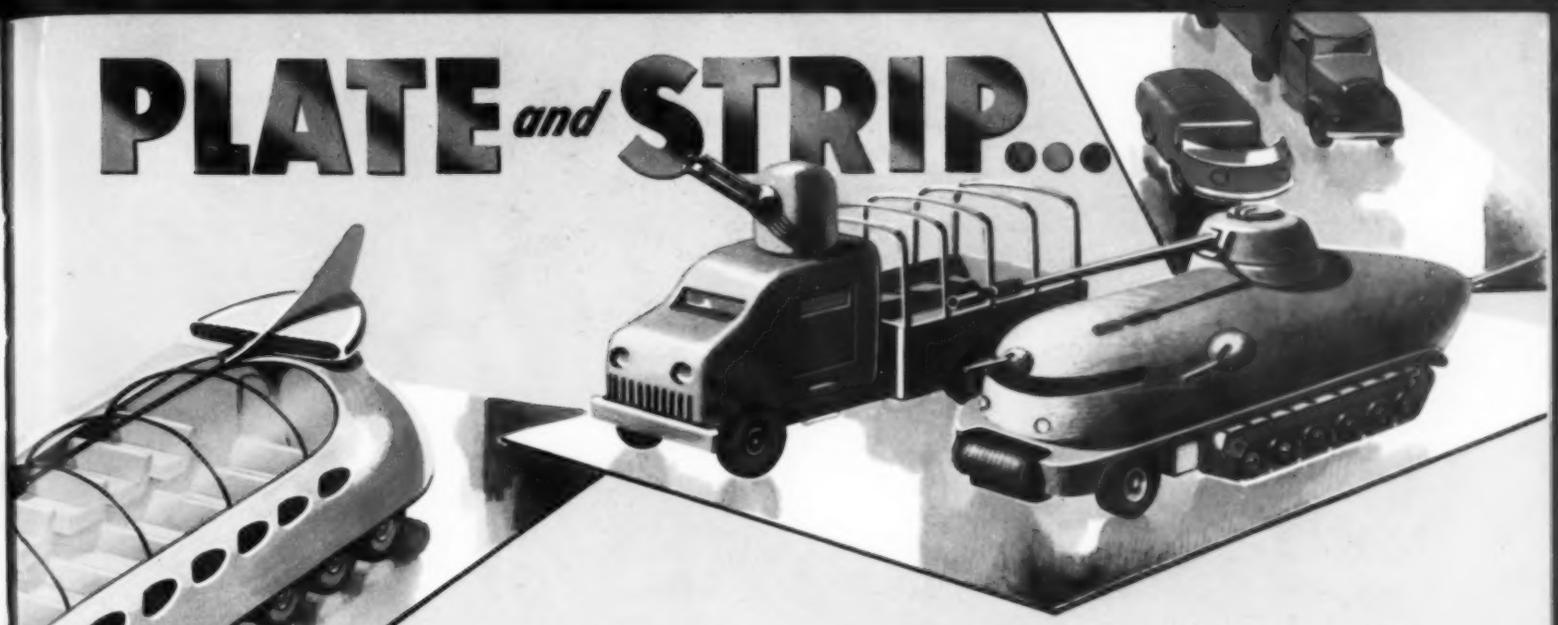
They're skilled workmen . . . proud of their jobs and proud of their company. The Okonite Company, Passaic, N. J.

THE BEST CABLE IS YOUR BEST POLICY

9549

insulated wires and cables

PLATE *and* STRIP...



Metal Hides

for WORK-HORSES and WAR-HORSES

Plate and strip mill rolling practices have come a long way since the first metal panels and trim were used for trucks and motorized armor—but as motor-makers' demands increased and specifications became more rigid Mack-Hemp Rolls were ready to take over the productioneering task.

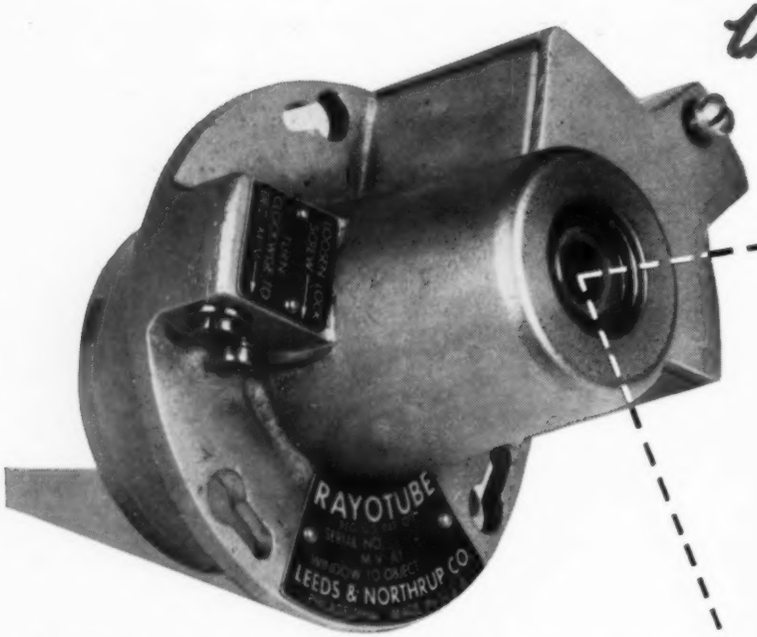
That's because Mack-Hemp engineers and metallurgists always keep ahead of the improvements in rolling mill practice—always coordinate their development programs with the operators and rollers. As a result *the rolls with the striped red wabblers* are familiar sights in every stand, for work and back-up, wherever plate and strip are produced.

You'll find that a large part of the plate and strip rolled for use in trucks and armored vehicles—an estimated 526,000 tons in 1950—came from mills equipped with Mack-Hemp Rolls, which is another good reason why it's always worthwhile to keep an eye on what's new at Mack-Hemp.

MACKINTOSH-HEMPHILL
COMPANY
PITTSBURGH and MIDLAND, PENNSYLVANIA
Makers of the Rolls with the Striped Red Wabblers

MACKINTOSH-HEMPHILL PRODUCTS INCLUDE: Rolls . . . Steel and Special Alloy Castings . . . Completely Integrated Strip Mills . . . Heavy Duty Engine Lathes . . . Mackintosh-Hemphill Rotary Straighteners . . . Improved Johnston Patented Corrugated Cinder Pots and Slag-Handling Equipment . . . Shape Straighteners . . . End-Thrust Bearings . . . Shears . . . Levellers

Can this new Rayotube mean better control of temperature in your plant?



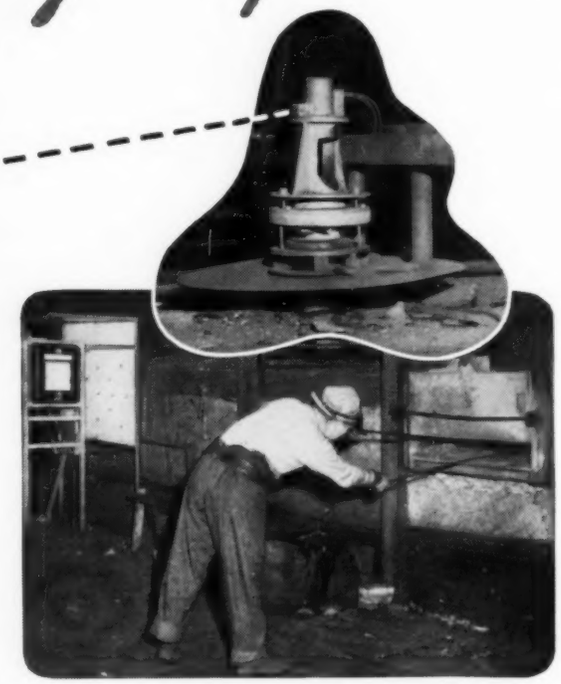
BUILT to detect temperatures for either Speedomax or Micromax Controllers, this new Rayotube No. 8890 has three features which help to improve the accuracy of control action.

1. The water jacket often needed for earlier Rayotubes is seldom required for this one because accuracy is not affected by ambient temperatures unless the head housing itself (shown above) exceeds 350 F. Omitting the jacket greatly simplifies installation and saves both water and maintenance due to water lines.

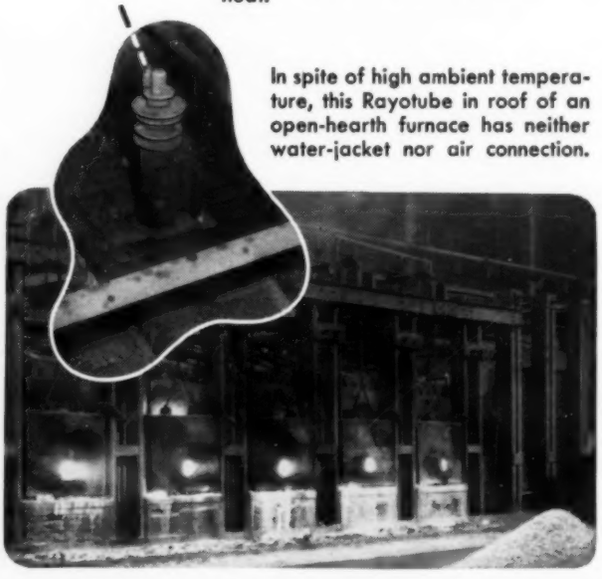
2. Overheating the Rayotube head to as high as 500 F does no harm; the accuracy decreases above 350, but returns fully as temperature drops. Thus, a few minutes' glare from an open furnace door does not affect the instrument's usefulness.

3. New, quick-sighting optical system for aiming the Rayotube at area of important temperature is especially helpful when aiming down an open-end tube to measure directly the surface temperature of parts being heated.

Catalog N-33B describes all Rayotubes as well as Speedomax and Micromax Pyrometers; we also can send description of this Rayotube only. Kindly address either our nearest office, or 4942 Stenton Avenue, Philadelphia 44, Pa.



In Henry Disston & Sons, Inc. plant, Rayotube in slab furnace roof needs no water-jacket against high ambient heat.



In spite of high ambient temperature, this Rayotube in roof of an open-hearth furnace has neither water-jacket nor air connection.

Jrl Ad NS3(2)

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For NORTHERN CRANES

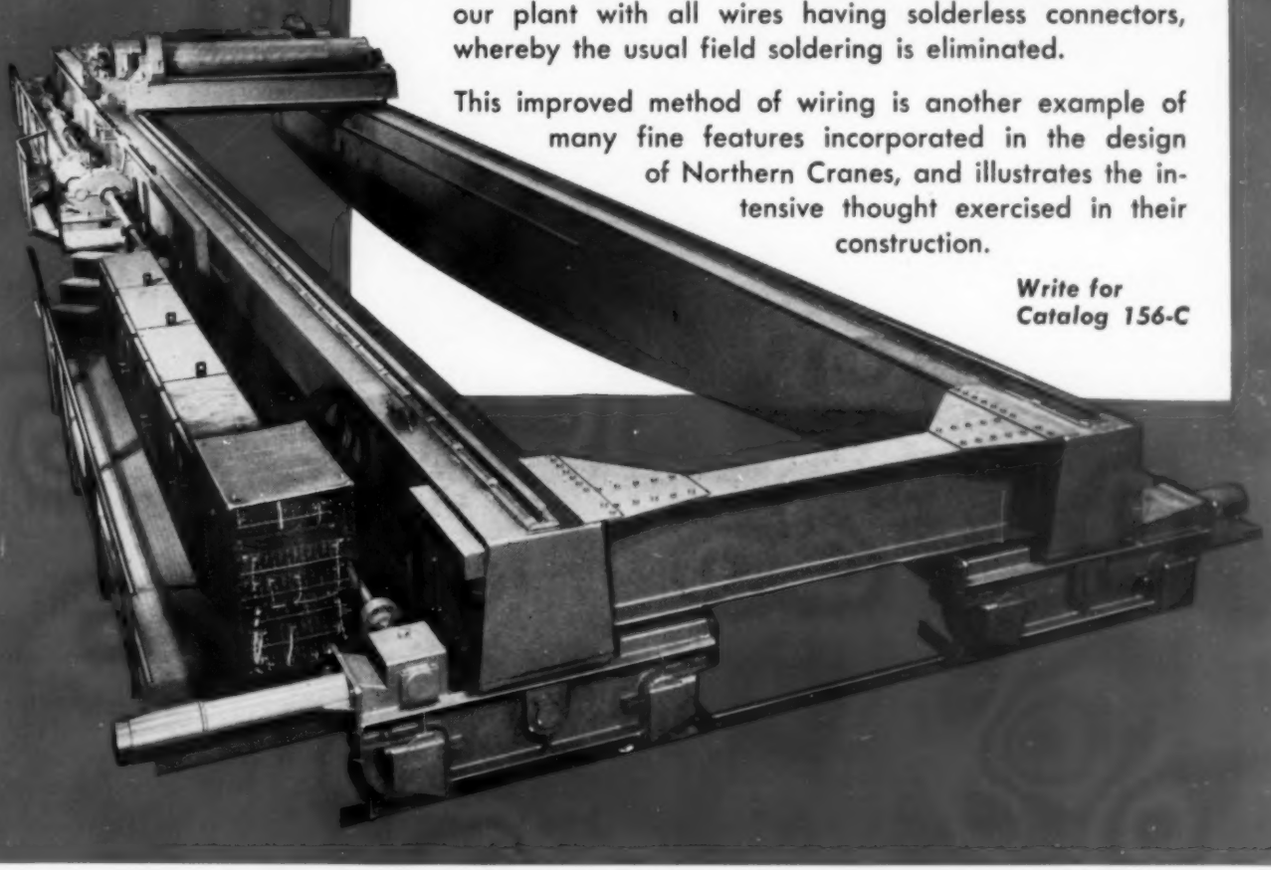
improved electrical layout

"Mounted on a Common Support"

For expedient field installation and wiring, all magnetic panels are mounted on a common support with all wires, where possible, contained in metal raceways having removable covers. Northern Cranes are completely wired in our plant with all wires having solderless connectors, whereby the usual field soldering is eliminated.

This improved method of wiring is another example of many fine features incorporated in the design of Northern Cranes, and illustrates the intensive thought exercised in their construction.

Write for Catalog 156-C



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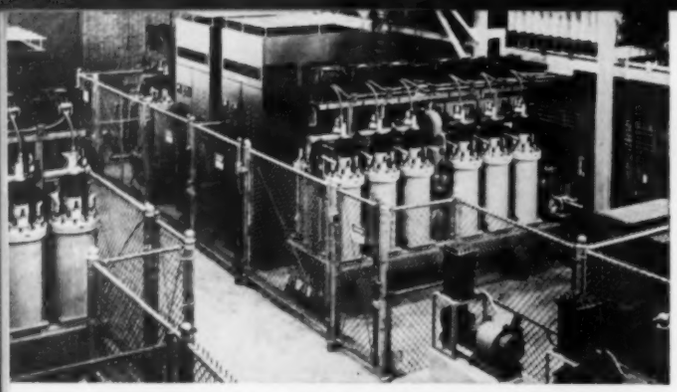
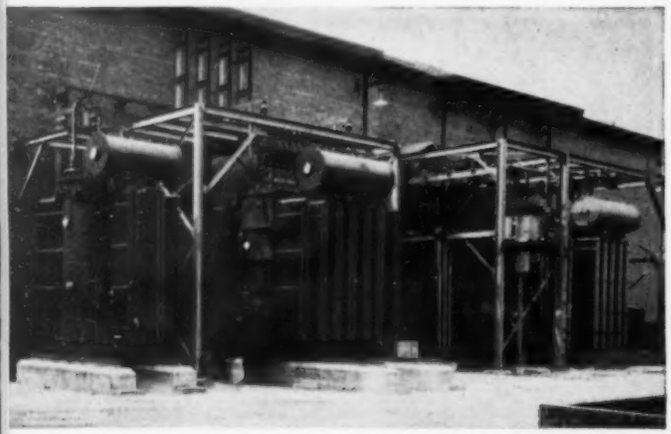
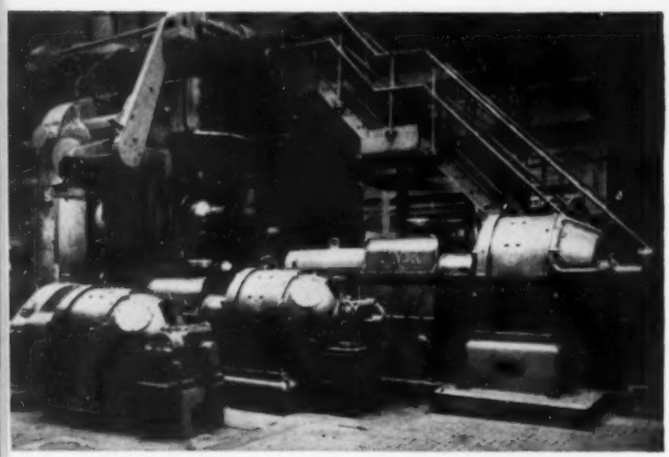


Interior view of building housing the Allis-Chalmers 16,000 kw mercury arc frequency changer. By-product power—largely generated by Allis-Chalmers steam turbines and gas engines at nearby Gary Steel Works and South Works — is converted from 25 cycles at 23 kv to 1750 volt dc along right side of building. Inverter along left side changes dc to 60 cycles at 6.6 kv linking with the purchased power system.

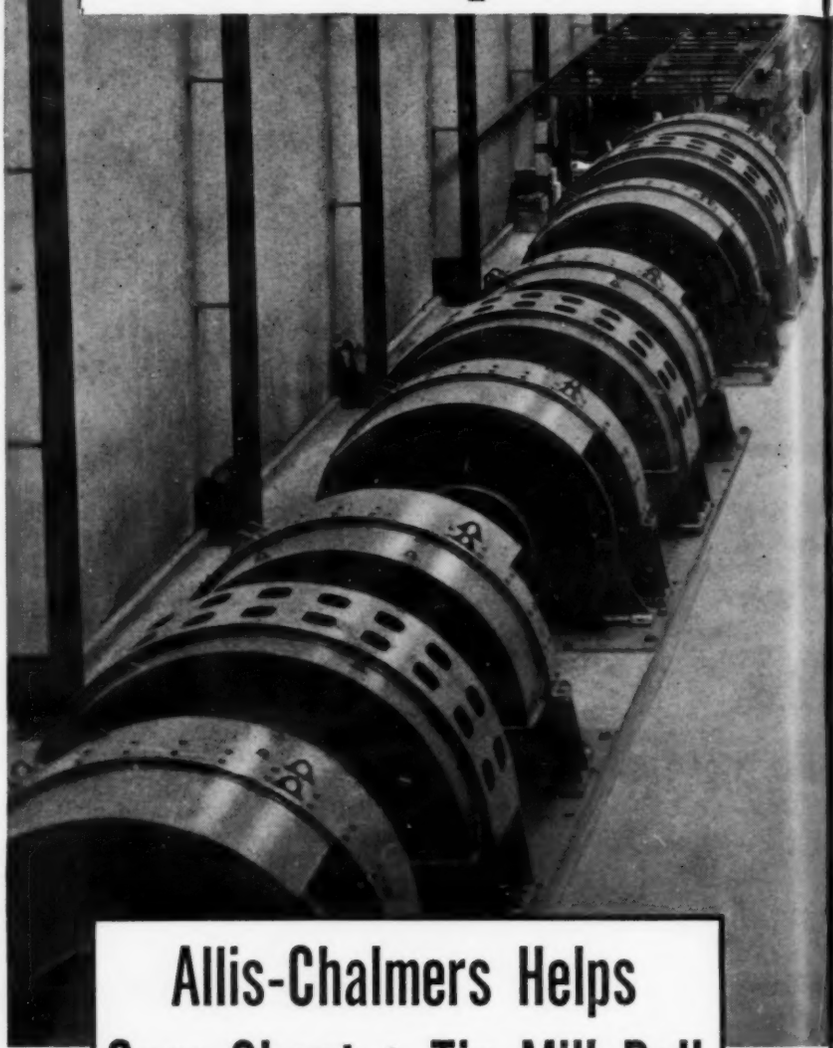


Allis-Chalmers rectifier transformers, reactors and oil circuit breakers serve the 16,000 kw mercury arc frequency changer. Outdoor equipment on the 60 cycle side is seen above. From left to right: dc reactor, 8000 kw self-cooled transformer, 15 kv, 500,000 kva i.c. oil circuit breaker, and 8000 kw self-cooled transformer.



Seen here is a veteran two stand temper pass mill still going strong after 15 years on the job. Allis-Chalmers dc motor drives, supporting synchronous M-G sets, switchgear, and control are employed on one single stand and four two stand tandem temper pass mills doing all the tinplate temper rolling.

15 Year Old Hot Strip Mill



Allis-Chalmers Helps Gary Sheet & Tin Mill Roll 2,377,274 Tons a Year

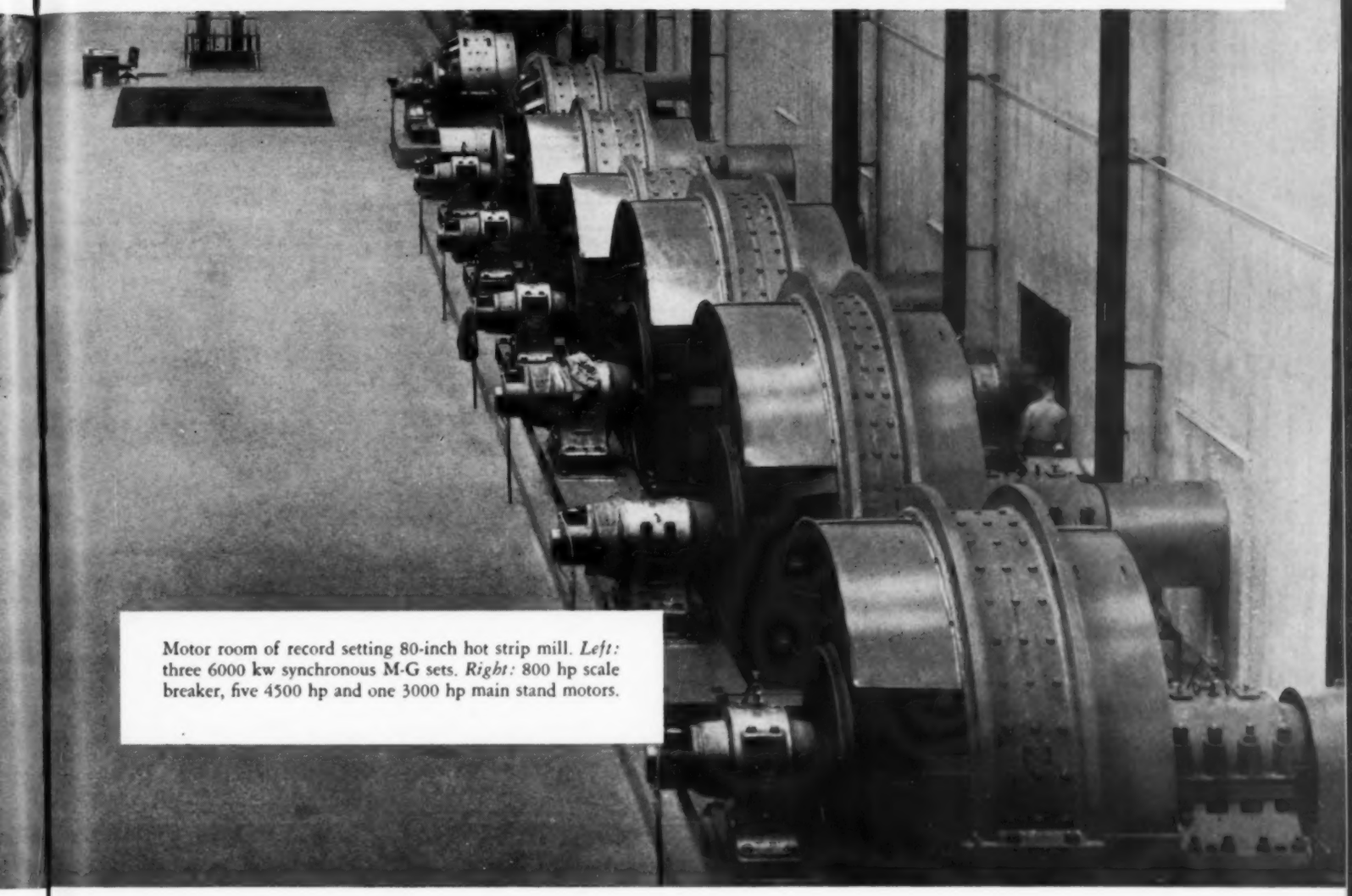
AFTER 15 YEARS IN OPERATION, this 80-inch hot strip mill in 1950 rang up a new annual tonnage world record of 2,377,274 tons! Top 8-hour turn was 4,147 tons. Top month was 222,751 tons. Equipment durability cannot be better demonstrated.

Located at the Gary Sheet and Tin Mill of the United States Steel Company, the mill rolls tough stainless steel as well as strip for regular sheet and tinplate products. Allis-Chalmers supplied the complete electrical equipment driv-

Power, Electrical, Processing Equipment for Iron and Steel

ALLIS-

SETS WORLD TONNAGE RECORD!



Motor room of record setting 80-inch hot strip mill. *Left:* three 6000 kw synchronous M-G sets. *Right:* 800 hp scale breaker, five 4500 hp and one 3000 hp main stand motors.

ing, supporting and controlling this veteran hot strip mill.

Originally installed in 1936, it has since been revamped to meet current demand. But the electrical equipment is still Allis-Chalmers with the original motors, generators and switchgear remaining in operation despite 15 years of punishing shock loads and sustained peak loads!

Allis-Chalmers quality equipment also is displaying durability elsewhere in the Gary Sheet and Tin Mill operation. Five Allis-Chalmers equipped temper mills (lower left) have been in daily operation for 15 years.

First Mercury Pool Frequency Changer

With equipment quality so thoroughly proved, the Gary Sheet and Tin Mill selected Allis-Chalmers to build the first commercial mercury pool type frequency changer in America (upper left). Now in its eighth year, it interchanges power between the 25 cycle system and the 60 cycle purchased power system.

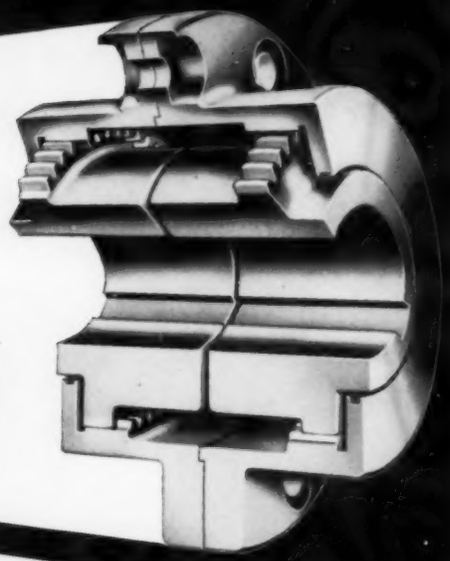
The 16,000 kw electronic frequency changer greatly increases flexibility and economy of operation by permitting full utilization of by-product power and reducing purchased power demand peaks. Other Allis-Chalmers mercury arc rectifiers also are used here to provide 250 volt dc mill supply.

Whatever your needs in electrical equipment for iron and steel production, A-C will supply you with dependable, quality equipment. For specific information on a *complete* range of generation, switching, conversion, rectification, drive, and control equipment . . . call your nearest A-C office or write to Allis-Chalmers, Milwaukee 1, Wis. A-3505

- CHALMERS

A-C ALLIS-CHALMERS

USE AMERIGEAR COUPLINGS FOR UNINTERRUPTED POWER TRANSMISSION



Two Developments That Mark The Beginning of A New Era In Power Transmission

The same principle is applied in effecting a positive seal of lubricant in the Amerigear Coupling as is used in sealing a Mason jar.

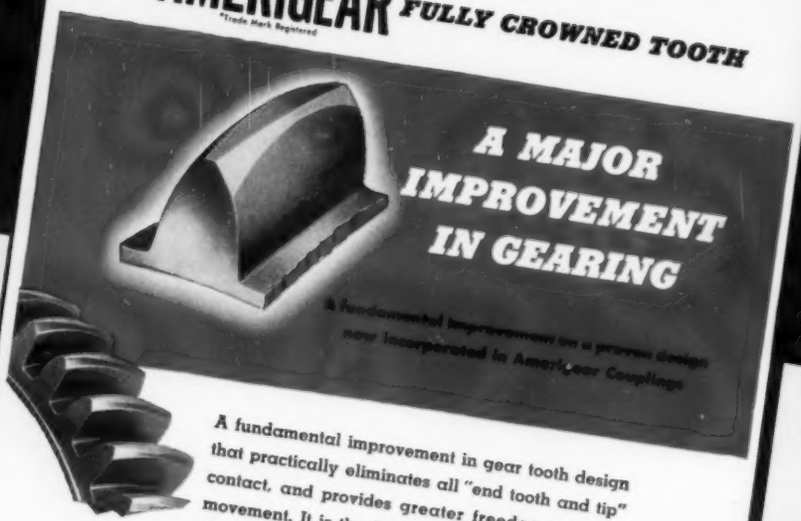
Positive Sealed-In Lubrication Prevents Wear And Assures Continuous Performance

As the coupling rotates, the lubricant is forced over all the crowned surfaces of each tooth, effectively cushioning the tight-fitting contact between the teeth at all times, thus preventing excess wear. This permanent film of lubricant is distributed evenly through the pumping action that continually occurs between the load-carrying surfaces, even during frequent and sudden reversal. Hub seal is held securely in place by special groove incorporated in housing design . . . seals in lubricant, keeps out moisture and foreign matter.

The Correct Combination of These Two Major Improvements by AMERIGEAR Engineers Lifts Power Transmission to an Efficiency Never Before Attained.

THE AMERIGEAR* FULLY CROWNED TOOTH

*Trade Mark Registered



A fundamental improvement in gear tooth design that practically eliminates all "end tooth and tip" contact, and provides greater freedom of axial movement. It is the first gear tooth on which all the load is carried on strong flanks rather than tooth edges. It reduces backlash to a minimum and permits greater load-speed capacity. The result of a program of continuous research and development, keyed to achieve higher efficiency in the transmission of power, the *Amerigear Fully Crowned Tooth* may be utilized in solving a wide range of special power transmission problems other than those common to gear-type couplings in which it is now incorporated. A folder on the Amerigear Fully Crowned Tooth is available on request.

AMERICAN FLEXIBLE COUPLING COMPANY

Originator of the Amerigear Fully Crowned Tooth • Sales Offices in Principal Industrial Centers

ERIE, PA., U. S. A.

AFFILIATE OF J. A. ZURN MFG. CO. • ERIE, PA., U.S.A.

Reproduction of recent announcement to Industry on Fully Crowned Tooth.

AMERICAN FLEXIBLE COUPLING COMPANY, ERIE, PA., U. S. A.

Originator of the AMERIGEAR Fully Crowned Tooth • *Sales Offices in Principal Industrial Centers*

AFFILIATE J. A. ZURN MFG. CO., *ERIE, PA.* Exclusive territories on these couplings available. Write, wire or phone for details.

Also
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Please send me further information regarding AMERIGEAR COUPLINGS with the Fully Crowned Teeth and Catalog No. 501.

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Company .....
Address .....
City ..... State .....
Please attach to your business letterhead. Dept. ISE

For general-purpose motors and generators . . .

NATIONAL
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STANDARDIZED BRUSHES

For general-purpose motors and generators, such as widely used SK, CD and many other types, there are no better brushes than "National" STANDARDIZED Brushes and no better grades than NATIONAL CARBON's 255 and SA-35. Each brush has been well built for its specific job. Both grades, 255 and SA-35, have been proved dependable by many years of satisfactory service in leading mills. Here are the plus values:

- **Unequalled uniformity**
- **Give most efficient machine operation**
- **Require minimum machine maintenance**
- **All at a *low flat price*, for one box or 10,000 boxes!**

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FOR GENERAL-PURPOSE MOTORS AND GENERATORS

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NC 20-4002	1¾ x 1¼ x ⅝ Grade 255	Type SK Motors and Generators
NC 12-4003	2 x 1¼ x ⅜ (15/15° bevel) Grade 255	Type CD Motors and Generators
NC 16-3205	2 x 1 x ½ (15/15° bevel) Grade 255	Type CD Motors and Generators
NC 12-4802	2¼ x1½ x ⅜ (35/20° bevel) Grade SA-35	Type CD Motors and Generators
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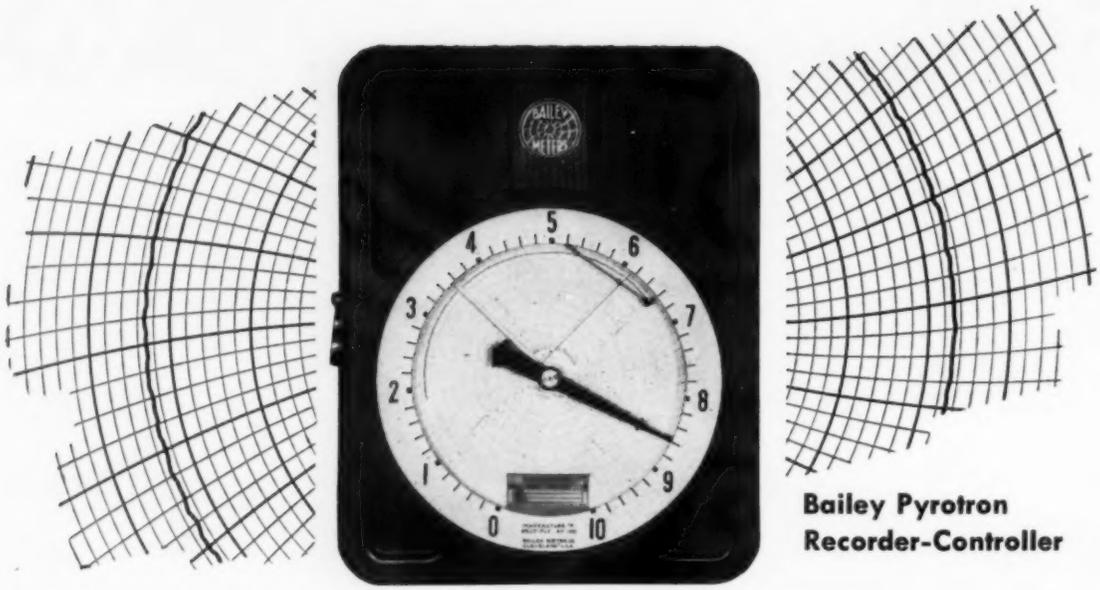
Order by NC Number

FOR COMPLETE INFORMATION on NATIONAL CARBON'S brush standardization program and the advantages it offers, write to National Carbon Company, A Division of Union Carbide and Carbon Corporation, Dept. IS.



Bailey Pyrotron Recorder-Controller

Looking for Better Temperature Instruments?

...Then check these features of Pyrotron Electronic Resistance Thermometers...

FUNDAMENTAL ACCURACY

Bailey Pyrotron Resistance Elements are made of highest purity platinum—the material used by the National Bureau of Standards in establishing basic standards for temperatures from −190°C to +660°C.

THREE TYPES OF CONTROL

Pyrotron Controllers may operate: on-off electrical systems by either electronic relays or electric contacts, modulated electronic systems, or air-operated systems. Two temperatures may be recorded on the same chart and controlled by a single instrument.

FACTS PUT INTO USABLE FORM

Bailey Pyrotrons may be arranged to put temperature facts into convenient usable forms. If two or more temperatures are related, they may be recorded as continuous records on the same chart for easy comparison. The average of several temperatures or the difference between two temperatures may be recorded as a single continuous record which may be retransmitted to a distant point or used to actuate a control system.

EASY INSTALLATION

Bailey Pyrotrons do not require careful leveling or protection against vibration. Three ordinary copper wires are all that is needed to connect each temperature sensitive element with the recorder. Power may be taken from any 115 volt 60 cycle circuit.

MINIMUM MAINTENANCE

The absence of galvanometers, batteries and standardizing equipment, together with the use of interchangeable unit assemblies, reduces Pyrotron maintenance to the vanishing point.

ABUNDANT POWER

A separate motor drive for each temperature furnishes abundant power to operate a recording pen, a controller and an alarm switch.

For the full story on this unusual electronic resistance thermometer which is suitable for ranges between −300°F and 1200°F, ask for Bulletin No. 230-C. P-21

BAILEY METER COMPANY

1047 IVANHOE ROAD • • • CLEVELAND 10, OHIO

Controls for Processing

TEMPERATURE
PRESSURE
% OXYGEN
% COMBUSTION
FLOW
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DENSITY
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CLARK EDGEWOUND RESISTORS

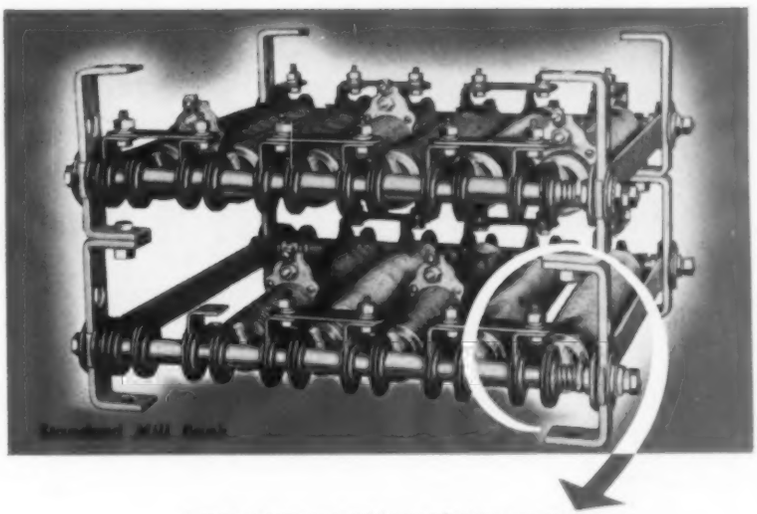
are built to withstand... VIBRATION

and individually engineered for every type of STEEL MILL APPLICATION

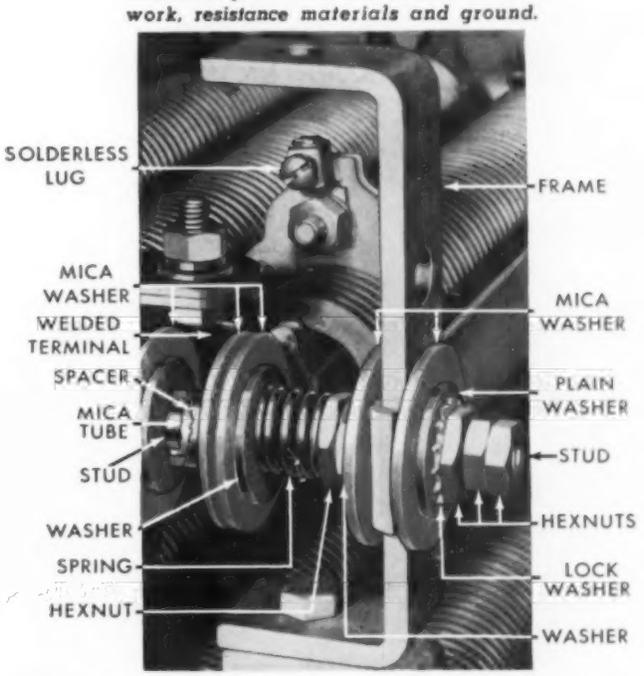
Thousands of CLARK Edgewound Resistors are giving trouble-free service in steel mill applications where vibration is excessive. They are especially recommended for use on Cranes, Ore Bridges, Car Unloaders, Open-Hearth Chargers and similar equipment. Clark Resistors are individually engineered to meet the demands of today's high-speed production machinery.

Note the many FEATURES engineered into all CLARK Bulletin 110 Edgewound Resistors—

- **Nonbreakable construction**
- **Shock resisting**
- **Light in weight**
- **Occupy small space**
- **Welded end terminals**
- **Individual units replaceable without bank disassembly**
- **Corrosive resistant material**
- **Negligible temperature coefficient**
- **Double insulation to ground**
- **Effective heat dissipation**
- **Flexible in application**
- **Current path not dependent on tightness of bank assembly**



Detail showing double insulation to ground. Insulation points (in red) between framework, resistance materials and ground.



Mill Bank with Solid Steel Frames

Let a CLARK engineer tell you more about Bulletin 110 Edgewound Resistors

THE CLARK CONTROLLER CO.

ENGINEERED ELECTRICAL CONTROL · 1142 EAST 152ND STREET, CLEVELAND 10, OHIO

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Brings your prospects to you
Introduces new products quickly
Produces inquiries and leads
Opens new markets for you
Establishes contact with people your salesmen can't reach
Builds sales organization confidence
Establishes your firm
Enables you to broaden your sales organization

Turning the tables on your customer

The 40-hour week is tough on your salesman. He can't reach all the people he should see. They haven't got the time to talk to him in THEIR place of business.

But there is one place where they do have time to talk to him—where they even ASK the salesman for a sales talk.

That time and place is at the particular Exposition which covers your own and your prospect's trade and industry.

Your prospects know that at these expositions they will find the latest and best products available in their and your field. They spend the time—plus millions of dollars—just to put themselves in a position where YOU can tell them about YOUR product.

Are you taking advantage of the opportunity?

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September 30 through October 3, 1952

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Right away manpower shortages and turnover problems solve themselves because OPERATORS appreciate the safety and speed and easy, finger-tip control of the *Bonnot Billeteer.*

And YOU — with the speed and efficiency of *Bonnot Billeteering,* can better meet today's "quantity and quality" demands by stepped-up output of better-conditioned billets. *Billeteering* also enables you to reduce inventories — makes chips 100% recoverable — eliminates excessive re-melting — guarantees accurate scheduling — reduces inventory.

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Engineered for Improved Production

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STEEL EQUIPMENT DIVISION
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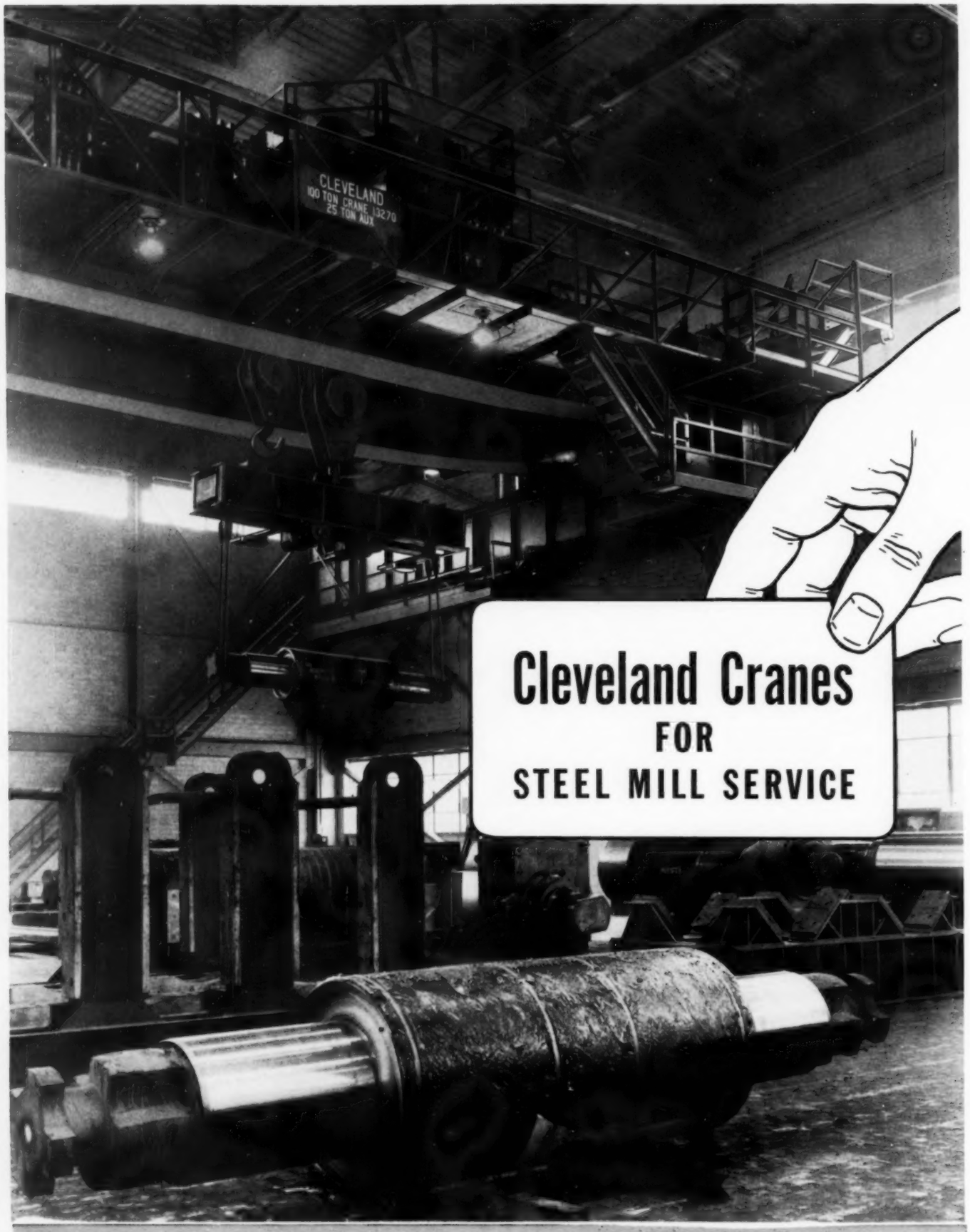

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RECENTLY one of our good friends wrote in to compliment us on the fine quality of reproduction of his company's advertisement in this journal. Long inured to castigation when things go wrong, we were so set up by this expression of appreciation that we passed the letter on to our printer. He, bearing much the same callouses as our own, was so tickled that he posted the letter on the shop bulletin board for perusal by the men who really did the job. Result—a lot of people got a lift from a simple little compliment.

With the memory of this incident still upon us, we tried a little of the same medicine ourselves. Impressed by the attitude and capability of a service man from one of the local utility companies during a service visit to our house, we called the service manager and told him about it. The manager was startled and very appreciative to hear a compliment instead of a complaint.

A little more of this on everyone's part might make life more pleasant.

▲

YEARS ago there were numerous stories about small town boys buying the Brooklyn Bridge or a solid brick of gold when they came to the big city —and it still happens. During our recent convention in Chicago, a very official looking check on the Riggs National Bank of Washington, D. C., was accepted in payment for some tickets and, of course, a fair amount of cash. The man was registered at the convention as P. A. Carpenter, a test engineer from the U. S. Bureau of Standards and was supposedly staying at the Drake Hotel. That's right—no account in the bank, no such person at the Bureau of Standards or at the Drake. Oh, well! Live and learn! What bothers us is whether he might have come back later and got a refund on the tickets.

▲

A RECENT article in Fortune magazine on the prevailing shortage of engineers tells about one company that sent out 22 of its own engineers to interview newly graduated engineers about jobs and got back only 21. The other was lured away by another scouting team on his travels.

The article goes on to say that there is a present shortage of some 60,000 engineers. Industry needs 30,000 per year for replacement and growth, while graduates are dropping from 25,000 in 1952 to a possible low of 12,000 in 1954.

▲

SOME economist says that the total money income of the American people in 1952 is expected to exceed the total goods available for consumption by more than $20,000,000,000. We think that is a gross under-estimate of the abilities of American womanhood.

▲

WAGE earners in the iron and steel industry averaged $1.974 an hour during the month of September, an all-time record, and current surveys show the steelworkers to be near the top in the country's wage scale. But as we go to press, negotiations have started between the major steel producers and the United Steel Workers on a heavy package of demands, including a wage hike estimated at 30 cents per hour, a guaranteed annual wage, union shop and various other items. Union men have hinted that they hope to break the wage stabilization setup —and of course their requests contain a lot of room for compromise. They know the more they ask for, the more they'll get. This cycle must stop sometime, but we'll bet that Washington will find some reason why a goodly portion of union demands should be granted.

▲

AN executive is a fellow who's always annoying the help with his bright ideas. But the proof of great executive ability is to convince your wife that you hired the pretty secretary because of her efficiency.

▲

IT doesn't seem so long ago that the papers and magazines were full of mournful predictions about the break-up of the home. People were always going out—no one stayed at home—dire consequences were bound to come of it. Then came television, and the home circle is restored—perhaps at the expense of some eye-strain and bulging waistlines resulting from accompanying nibbling and tippling—but lots of people stay home to watch it. And so the various entertainment businesses are worrying about attendance, blaming the falling off on television and in some cases (for example, the National Collegiate Athletic Association), trying to ban television in their own fields. If their short memories would recall that glorious experiment, the 18th amendment, they should realize that you can't legislate public tastes. If they would expend their efforts toward making their own offerings more attractive, they would hold their own. TV programs aren't so darn hot.

▲

THE Mahoning Valley Technical Societies Council in Youngstown, Ohio, wants to obtain a file of AISE Yearbooks for their library. Perhaps some member in the Youngstown district who is no longer using his Yearbooks would like to donate them to this library, where they will be of use to a large segment of valley industry.

▲

IT is hard to realize that another year has rolled around. Father Time has a way of continually accelerating his cycle. Each year seems shorter than the last, and each year seems to show more and more to be accomplished. No doubt you're thinking that this is a sign of age, but we still pay as much attention to the waitress as we do to the food—well, almost as much.

In any event, it is again time to wish all of our readers and loyal supporters the happiest of holidays and the best for the new year.

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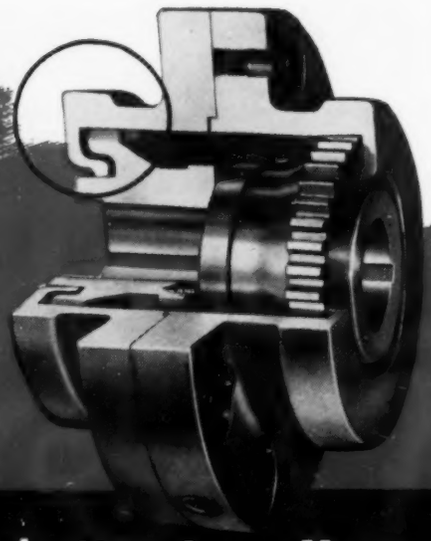

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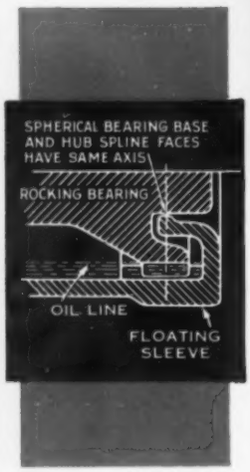

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New Aetna-Standard tube mill to speed production with 1211 TIMKEN® bearings

A NEW seamless tube mill, being built by The Aetna-Standard Engineering Company, will soon be completed for use in the Chicago district. And to insure higher speeds, greater precision, long life and minimum time-out for maintenance and repairs, Aetna is using Timken® bearings on roll necks, drives, thrust blocks, screw downs and troughing table rolls. A total of 1211 Timken bearings!

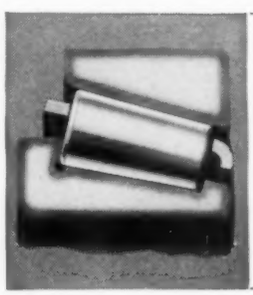
It's estimated that 95% of America's seamless tubing is produced on mills equipped with Timken bearings. First choice throughout industry, Timken tapered roller bearings are your guide to top value. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

Here's where the 1211 Timken bearings are used in the new Aetna-Standard seamless tube mill:

Two 36″ piercing mills	50
24″ plug mill	10
Two 30″ reelers	26
14-stand 16½″ reducing mill	412
7-stand 20″ sizing mill	136
17″ Assel mill	92
13″ rotary sizing mill	16
Troughing table rollers	469
TOTAL TIMKEN BEARINGS	1211

A 36″ piercing mill typical of two being built by Aetna-Standard for a new seamless tube mill in the Chicago district.

AETNA-STANDARD mounts Timken tapered roller bearings on the roll necks of their 36″ piercing mills. Typical Timken roll neck bearing application is shown at right.



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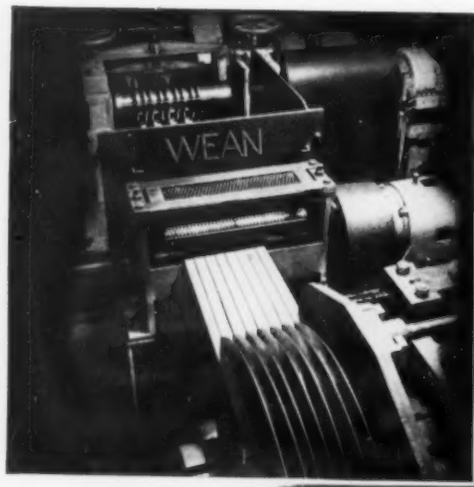

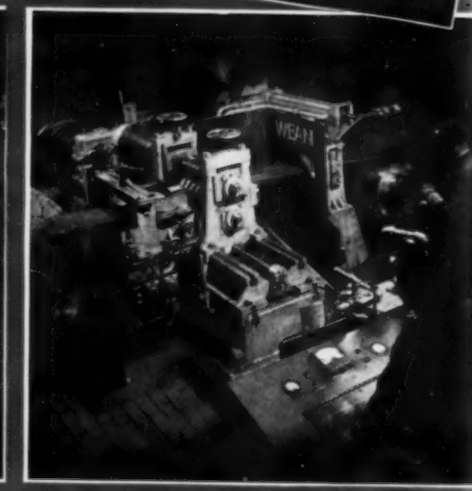

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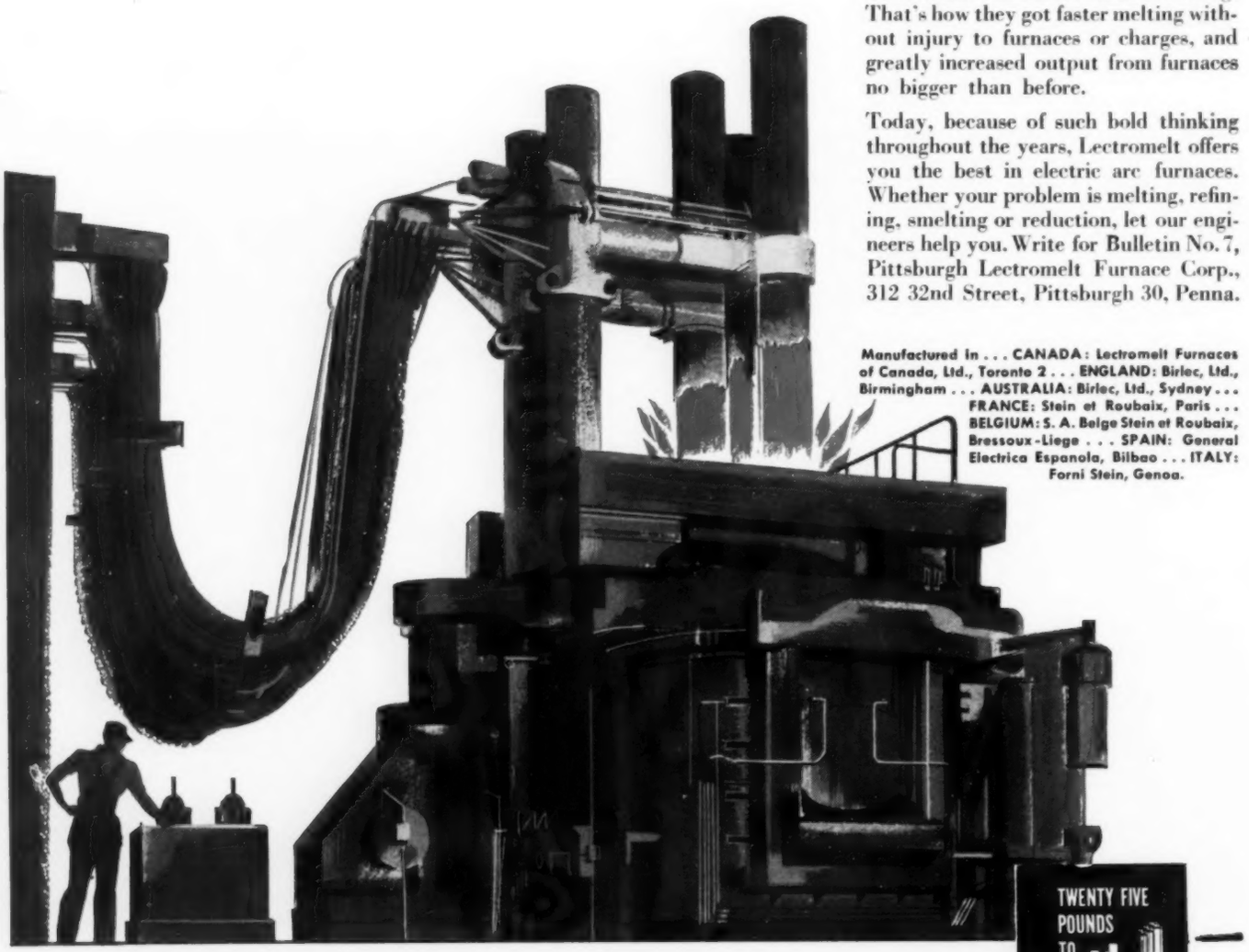

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WHEN YOU MELT... MOORE RAPID *Lectromelt*

Effect of Track Time

ON SOAKING PIT HEATING

By J. R. CHEGWIDDEN
Superintendent, Saucon Mills
Bethlehem Steel Co.
Bethlehem, Pa.

. . . . good transportation holds the key to good track time . . . .

▲ TRACK time, the time consumed for the delivery of a heat of steel from the open hearth to the soaking pits, is measured in hours and minutes, and evaluated in terms of temperature or heat content remaining in the ingots as received by the soaking pits.

As good track time is vital to the economic life of a soaking pit operation, it is the purpose of this paper to offer or suggest, through the medium of an analysis of those operations included in the measurement of track time, possible ways of improvement and a more accurate means of evaluation, other than, in mill terminology, of "Red Hot, Hot, Black Hot, and Cold."

However, before progressing with the analysis of these operations, it is first necessary, for the sake of clarity, to identify the materials used as a basis of this discussion.

Recognizing that different types of steels, molds, and mold sizes vary in degree of effect on the subject, the writer confines all data and conclusions to semi-killed, low-carbon (0.18/0.23) steel, and the big-end-down mold. For simplicity of illustration, the popular small 20 × 24 × 81 in. ingot weighing approximately four and one-half tons, was chosen. This ingot size was also selected for its quick reaction to varying track time.

To continue with the discussion; the operations to be analyzed, in their sequence of time and temperature, are as follows:

1. Open hearth tap to teem or hold time. (Time of tap being taken when ladle is full of steel).
2. Teeming and solidification.
3. Stripping.
4. Transportation or ingot exposure to the atmosphere.

For the first operation, tap to teem, average heats of about 125 tons were selected for this study, and the average hold time was established at 10 minutes, when tapped at 2860 F and teemed at 2770 F. As this track time is measured from ladle, steel full, actual ladle temperature is estimated at 2810 F, or the starting point in time and temperature for this study. Both tapping and teeming temperatures were determined by immersion platinum thermocouple measurement; the temperature of tap taken in the bath just before tap, and the temperature of teem taken in the second mold after its teeming was complete. Although it is known that variances in tapping and teeming temperatures do affect both the measurement and evaluation of track time, for this example, they will be considered as constants.

An examination of teeming and solidification is always a subject of general interest and this one proves to be no exception to the rule. Having in mind the Gathmann theory of big-end-down ingot solidification, illustrated by his photography of the solidification of wax and showing the point of completed solidification below the center of the ingot, an attempt was made to explore this theory by the use of immersion thermocouples (Figure 1).

Choosing the second mold in a string of twelve 20 × 24 in. molds, a carborundum closed-end tube, with 1¾ in. outside diam and 1-in. inside diam, and containing a porcelain tube of 11/16-in. outside diam and 7/16-in. inside diam, was suspended from the top and in the center of the mold, so that it would immerse in the ingot to a depth of thirteen inches, as shown in Figure 1. The second mold was chosen so that the effect from the radiant heat of adjacent molds on each side would

Figure 1 — Immersion thermocouples were used to measure temperatures in the ingot.

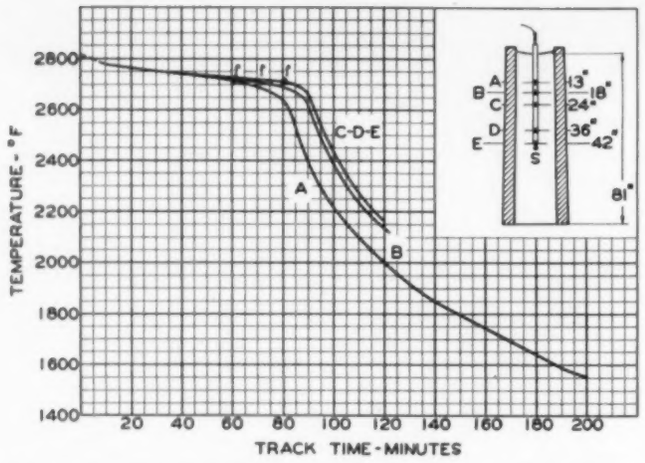


Figure 2 — The solidification time at point A is shown by these curves.

be included in the experiment. The molds were poured, and a platinum thermocouple was inserted into the porcelain tube of the second ingot. Recorded temperatures were taken, and the resultant solidification curve for the point A is illustrated in Figure 2.

This point A, was chosen to represent relative internal temperature in further examinations of successive operations, including soaking pit heating.

The point of freeze or solidification is estimated to be at (f) on the A curve, where the temperature drop starts to accelerate, or in track time, 60 minutes.

The above experiment was repeated for the depths of 18, 24, 36 and 42 inches. It may be well to add here that considerable difficulty was experienced in maintaining the thermocouple wells at these depths. The carborundum tube usually failed too quickly to allow the porcelain tube to adjust itself to withstand the high thermal shock. By placing a quartz tube within the porcelain tube, readings were finally secured at these depths. No success was had with immersion experiments beyond a depth of 42 in.

At the 18-in. depth, the point of freeze was extended to 70 minutes of track time as indicated by the point (f) on the B curve.

The temperature recordings for the depths of 24, 36 and 42 in., fell into practically the same solidification curve, and too close to be separately illustrated on this chart. It is therefore assumed, from this data, that from the accelerated speed of solidification between the 24-in. reading and the 42-in. reading of three minutes, the point S, denoting complete solidification, must be slightly below E, in respect to its location in the ingot. As this mold size has a slight taper of three-quarter of an in. in its 84 in. of depth, this is a reasonable assumption and the point (f) on curve CDE, is taken as the point of complete solidification for this 20 × 24 × 81 in. ingot, at 80 minutes of track time. For this study, this time was taken as the earliest time of strip.

Up to this point in our study, little improvement can be made in reducing time consumed or temperature lost. The remaining operations to be analyzed, hold the key to good track time.

Stripping time, is dependent upon the amount of crane service available, and the timely positioning of buggies by the railroad, to receive the molds as they are stripped. For this examination, actual stripping time will be included in exposure-to-atmosphere time as stripping time determines the point of ingot exposure to the atmosphere.

To demonstrate the influence that ingot exposure to the atmosphere has to the heat content remaining in the ingot as received at the soaking pits, a comparison was made of the temperature drop between the ingots in the molds and those exposed to the atmosphere, at various stages of track time.

To accomplish this comparison, two sets of six molds were poured with a 13 in. thermocouple well cast in the second ingot of each set. Internal temperatures were recorded until time of complete solidification. One set of ingots was then stripped and internal temperatures

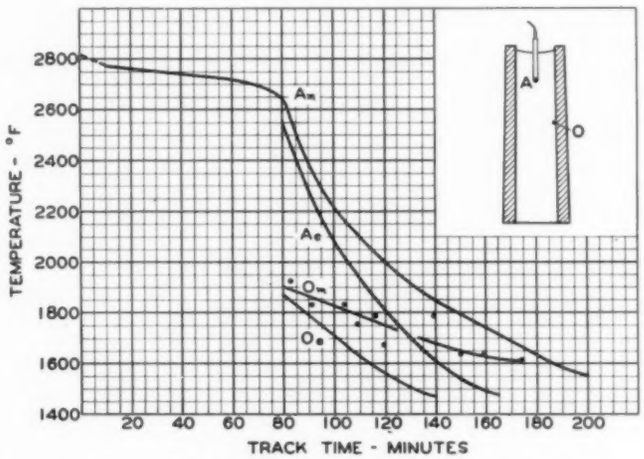


Figure 3 — Cooling of ingots, exposed to the atmosphere, are shown by these curves.

were again recorded. Immediately after stripping, optical pyrometer readings were taken every five minutes, at the hottest portion of the ingot side opposed to the adjacent ingot. This spot appeared to be in the region of the center or slightly above. See Figure 3.

With this experiment, the cooling curve Am, indicating temperature drop at point A of the ingot in the mold, was obtained.

The curves Ae and Oe were also established for the internal and skin temperatures of the ingot exposed to the atmosphere.

The curve Om, or skin temperature of ingot within the mold, was plotted from optical and radiation pyrometer reading of ingots of varied track times, from time of tap to time of strip. Each reading was taken at time of strip.

In comparing these curves, the sharp reduction in temperature for a given track time of curves Ae and Oe versus Am and Om, emphasizes the loss of heat due to ingot exposure.

The potential heat salvage in the first 30 minutes after minimum strip time indicates the importance of fast movements of heats in transportation.

It can also be noted, that two heats of the same track time can vary in heat content, depending upon ingot exposure.

From this comparison it is obvious that exposure to the atmosphere should be cut to the minimum. Stripping location and transportation therefore should be

examined, as they are the controlling factors in ingot exposure.

The ideal stripping location, from a soaking pit heating standpoint, would be practically under the soaking pit crane runway. However, as most stripping locations are not readily changeable, the emphasis must be placed on the other factor, transportation.

The basis of good transportation is a mutual understanding and knowledge, by both railroad and operating departments, of the problems involved in maintaining a continuous flow of hot steel to the pits.

To accomplish this, a fast means of communication is necessary to direct railroad movements at all points of its travel to anticipate heat movements and buggy return for mold stripping.

Of equal importance is the tie in communication system between the railroad and operating departments, to interchange information as to open hearth, soaking pit, or mill conditions, which may affect track time.

Bunched heats always present a difficult problem. To strip and hold in the soaking pits until pit room can be obtained, is too often the procedure. It is self evident, from observation of curves Om and Oe, that if possible, these heats should be held in the molds as long as practical until pit room is realized. The word practical, is used, because there is a limit to the number of buggies and molds that can be held up, without interference to the movement of succeeding heats.

At times and dependent upon mill conditions, it is

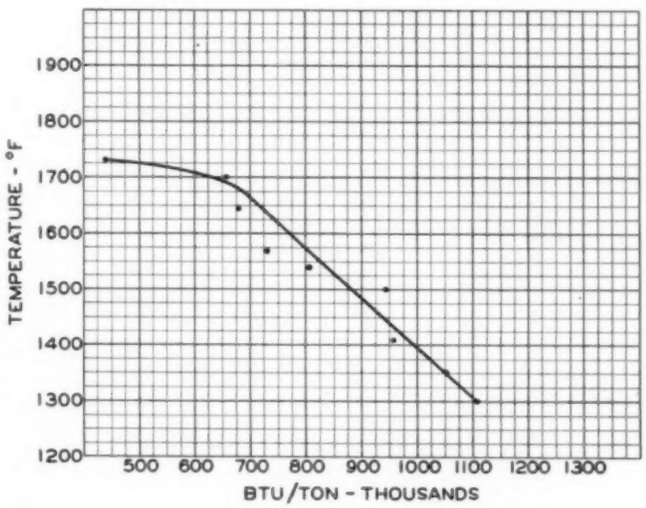


Figure 4 — Allowing the skin temperature to drop increases markedly required Btu's per ton.

advisable to deliberately sacrifice one or two heats to long track time or the cold steel bank, to insure the continuity of flow of hot steel and avoid potential mill-down time.

Without communication systems, any control of the above conditions would be extremely difficult.

With the analysis of track time completed, a study of its evaluation and effect on soaking pit heating is now in order.

It has been shown in Figure 3, that ingots having the same track time can vary widely in their heat content. To more accurately evaluate this heat content of the ingot as received at the soaking pits, the optical pyrometer is suggested as a practical application. From check readings of ingots received at the soaking pits, by both optical and radiation pyrometers, it is concluded that skin temperatures above 1450 F can be measured by optical pyrometer, within a reasonable degree of accuracy; below this temperature, pyrometer crayon sticks are used.

In preparation for the study in soaking pit heating, twelve ingots, representing a heat, were used as a basis of test. The second ingot, in each representation, contained a thermocouple well at point A. Nine heats of varied track time were represented, and the following procedure was established:

To obtain a good spread of heating data, stripping was sometimes delayed to get an even variance in track time.

Inside and skin temperatures were recorded at the time of charge into the pits. The inside temperature was taken by platinum thermocouple on the pit floor just prior to charging. The skin temperature was read by optical pyrometer.

Twelve ingots were charged into a rectangular 12 ft-9 in. × 8 ft-6 in. × 10 ft-0 in. coke oven and blast-gas fired pit having regenerative type checkers. The test ingot was charged in the center of pit and platinum thermocouple was inserted through a hole in the cover into the well at point A. By placing this ingot in the center to record internal temperature, only twelve ingots could be charged, covering 37 per cent of the hearth area.

To eliminate as many variables as possible in succeeding heating tests, the following conditions were held constant:

1. The same soaking pit was used for all tests.
2. Furnace pressure—balanced.
3. Mixed gas of 135 Btu per cu ft was held to as nearly as possible, until pit temperature reached 2400 F. Coke gas was then cut back.
4. Heating time cycle—Time of first ingot charged to time of draw.
5. Pit temperature—Radiation pyrometer.
6. Ingot inside temperature A—Platinum thermocouple.

Figure 5 — Allowing the skin temperature to drop also increases the heating time.

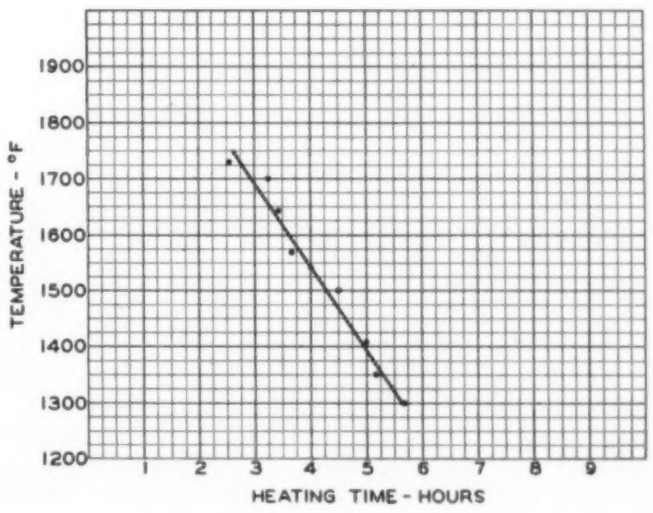


TABLE I — SOAKING PIT DATA.

TRACK TIME HRS.	CHARGE TEMP. SKIN-°F	CHARGE TEMP. INSIDE "A"-°F	BTU/CU.FT. COKE	BTU/CU.FT. BLAST	FUEL CONSUMP. IN CU. FT. COKE	FUEL CONSUMP. IN CU. FT. BLAST	TONS HEATED	DRAW TEMP. PIT-°F	DRAW TEMP. INSIDE "A"-°F	HEAT'G TIME	BTU/ TON
1:30	1730	2285	534.0	91.3	16,800	168,000	55.6	2340	2330	2:35	437,200
1:50	1700	2090	529.0	93.2	24,800	264,000	56.8	2340	2340	3:15	664,000
2:10	1640	1930	541.0	92.0	26,400	264,000	56.8	2340	2330	3:25	679,100
2:30	1570	1650	529.4	91.8	26,400	288,000	55.4	2340	2330	3:40	729,500
2:45	1540	1610	526.4	92.2	31,200	330,000	57.5	2330	2330	4:00	814,777
3:00	1500	1590	533.0	93.0	36,000	360,000	55.8	2340	2345	4:30	943,000
3:15	1470	1525	537.6	91.8	36,000	384,000	56.9	2340	2355	4:45	959,600
3:30	1350*	1510	539.0	92.3	38,400	432,000	57.3	2340	2350	5:10	1,057,000
4:00	1300*	1410	528.0	91.0	38,800	456,000	56.1	2345	2350	5:40	1,104,900

* - TEMPIL STICK TEMPERATURE

7. Pit charge—Twelve 20 × 24 × 81-in. ingots.
8. Coke and blast-gas consumption metered.
9. Automatic reversal—10 minutes.
10. Draw temperature—Aim 2340 F at point A.

In beginning the first test, the point A in the ingot was taken as the cold spot in the ingot and the control for time of draw. To support this assumption, a test ingot, with a thermocouple well cast 36 in. deep in the center of the ingot, was heated, and, at draw temperature of 2340 F at point A, the platinum thermocouple in the 36 in. or D reading was 2360 F, or twenty degrees higher than the selected control point A. See Table I.

The first twelve ingots to be heated were given express transportation and the first ingot was charged one hour and thirty minutes from time of tap to time of charge, or ten minutes from time of strip. This is the best possible delivery time of a heat under existing conditions, for this study. Therefore, this test will be the model performance for reference, in the examination of others.

The results of this first study are shown in the first line of Table I.

The skin temperature of 1730 F and inside temperature A of 2285 F indicate the relative heat content remaining in the ingot. The weight of this heat salvage is felt in the low heating time and low Btu per ton required to process this test. In direct comparison, the last test in Table I, of a heat with a four-hour track time, whose inside temperature is fast approaching skin temperature, denotes a tremendous fuel requirement and heating time which severely penalizes both the economy and capacity of a soaking pit operation.

To further accentuate the effect of track time to soaking pit economy, Figure 4, plotted from soaking pit data in Table I, clearly shows the increase in fuel requirement as the heat content diminishes.

The first point on the curve is from our model test with a skin temperature of 1730 F and an internal temperature of 2285 F. Note the effect which the drop of 185 degrees internally with a 30-degree skin-temperature drop has on the Btu per ton. Here again, the need for fast movement of the heat immediately after stripping, is stressed.

Figure 5, also plotted from data contained in Table I, presents skin temperature versus heating time. As soaking pit capacity is based on heating time, the significance of this curve in its effect on soaking pit capacity is apparent. With a drop in skin temperature of 430 F, the heating time is more than doubled, increasing from two hours and thirty-five minutes to five hours and forty minutes.

In summarizing the contents of this paper, the following observations can be made:

To analyze track time, a knowledge of ingot solidification time is necessary.

For this example, transportation holds the key to good track time.

Co-ordination and co-operation between railroad and operating personnel, through the medium of good communication for the interchange of information, is necessary, to obtain efficient transportation.

A more accurate means of evaluating heat content is offered through the use of the optical pyrometer at the soaking pits.

Both soaking pit economy and capacity are dependent upon track time or ingot heat content, as received at the soaking pit.

The procedures outlined in this paper, in the analysis of the subject, are not necessarily actual operating practices. Their purpose, in this study, was to establish a model performance of track time and heating, for a picture in contrast, to possible actual conditions.

To truly evaluate the effect of track time to a soaking pit operation, analyses of the various types of steel, molds, and ingot sizes used in the flow of steel through the soaking pits, would be necessary. The procedure, data and conclusions contained in this paper are only offered as a relative yardstick in the method of approach to an evaluation of track time.

DISCUSSION

PRESENTED BY

FRANK W. HAWKINS, Supt. Slab & Bloom Div., Ford Motor Co., Dearborn, Mich.

J. R. CHEGWIDDEN, Superintendent, Saucon Mills, Bethlehem Steel Co., Bethlehem, Pa.

T. W. LEWIS, Superintendent 45-in. Slab Mill, United States Steel Co., Homestead Works, Munhall, Pa.

C. W. KING, Superintendent Hot Strip Mill, Newport Steel Corp., Newport, Ky.

P. E. HAGLUND, Superintendent, Raw & Semi-Finished Steel Operations, Ford Motor Co., Dearborn, Mich.

V. T. MARCONI, Superintendent Rolling Mills, United States Steel Co., Vandergrift, Pa.

H. H. NORTHRUP, Open Hearth Superintendent, Republic Steel Corp., Buffalo, N. Y.

Frank W. Hawkins: What effect does holding the ingots in molds have on mold life?

J. R. Chegwidden: There may be some loss of mold life due to holding the ingots in the molds, but I believe the gain in soaking pit economy through a reduction in "exposure to atmosphere time," will more than compensate for any resultant decrease in mold life.

T. W. Lewis: What effect have your studies shown on the quality of product obtained in relationship to good track time from the heating cycle you have shown?

J. R. Chegwidden: There is always an advantage from a quality standpoint in having good track time. The tendency to push long tracktime heats through the soaking pits to meet mill schedules often results in burned steel and ingots not thoroughly soaked when rolled. When this happens, increased rejections at the inspection bed can be assured. However, the relationship between quality and track time is much closer in the alloy grades of steel than in the subject grade, semikilled low carbon steel.

T. W. Lewis: This paper offers a novel technique by which sound bench marks may be laid for establishing the optimum flow of ingots for any given set of plant operating conditions. The overall evaluation of the causes, effects and inter-relationship of holding time, stripping time, exposure time and heating time have been made many times in a rough approximate manner and such appraisals have been of considerable value with the mill operators. However, the expression of these variables in terms of actual measurements represents the ideal approach to the solution of an operating problem of this type.

Member: I noticed on the table for the three hour track time, your inside draw temperature was hotter than your outside draw temperature, and prior to the three hour time, your outside was the hotter. What relation is there between the two as far as quality? I would assume that your inside section is the hotter of the two, and as far as quality when the ingot is rolled, that you would be more likely to find that older track time with the hotter inside temperature would be in favor.

J. R. Chegwidden: At these high temperatures, I do not believe these differences of 5 to 10 degrees will have any effect on quality. This variation in some of the data for inside "A" and pit draw temperatures resulted from our inability to score 100 per cent in our aim to equalize both of these temperatures at exactly 2340 F, at point of draw. As both recording temperature instruments and a check potentiometer were used to reduce errors in recording to a minimum, it was felt that these slight differences would have little or no influence on the conclusions derived from the subject data.

C. W. King: What method of communication do you have between your pits and transportation?

J. R. Chegwidden: We have a public address system of transmitter and receiver stations located at various vantage points in our transportation system, open hearth, and soaking pit departments.

A radio system used in the transportation system of the Carnegie-Illinois Steel Corp., Homestead Works, appears to be a better means of communication for complete control of engine movement.

P. E. Haglund: Is that eighteen to twenty-three carbon steel you are rolling?

J. R. Chegwidden: That was point eighteen to point twenty-three carbon steel.

P. E. Haglund: Is your maximum drawing temperature under 2350 F in the soaking pit?

J. R. Chegwidden: Yes, our aim was a 2340 F draw temperature for this 20 × 24 in. ingot used as an example in this paper. Larger size ingots for heavy structural sections have draw temperatures of 2375 to 2400 F.

Member: What is the sulphur content of that steel?

J. R. Chegwidden: Sulphur content will be under 0.04 per cent.

Member: What is your desirable finishing temperature?

J. R. Chegwidden: The finishing temperature varies with the application of the 20 × 24 in. ingot. If rolled into the light wide flange sections on the universal mill, we try to stay above 1650 or 1700 F. If rolled into billets or blooms for the standard mills where further re-heating takes place before re-rolling, finish temperatures are not as important, and can vary between 1700 and 1950 F depending on the size of billet or bloom to be rolled. Ninety per cent of our 20 × 24 in. ingots rolled fall into this latter category.

V. T. Marconi: I have noticed that the fastest track time you had was an hour and a half; what do you think of one hour track time, what would be the results?

J. R. Chegwidden: Using the solidification curves

in Figure 2, it can be noted that with a one-hour track time, stripping would have to take place at about 45 minutes of track time. At this point, the molten interior of the ingot could be expected to extend to a point above point "A." In an attempt to strip at this stage of track time, it is doubtful whether the mold has reached its maximum expansion to create any separation from the ingot. It is also doubtful whether the crust above point "A" will support much pressure from the stripper plunger to assist in forcing a separation between mold and ingot without breaking through into the molten interior of the ingot. In addition to stripping difficulties, the question arises as to the effect the handling of ingots while still in a partially molten state has on quality of product. This can be a controversial subject; however, I believe it is generally conceded, that rough handling of any ingot in this state can be detrimental to good quality of product.

Member: I would like to get one point cleared up. This finishing temperature, 1700 to 1650 F, is for what size, a billet or bloom? I understand your draw temperature is 2350 F, if you aim to finish between 1650 and 1700 F, you must lose a lot of heat somewhere. You need to heat up to 2350 F, if that is your standard.

J. R. Chegwidden: The temperatures 1650 to 1700 F refer to the finished product. If this ingot is applied to a universal mill, there will be considerable heat lost in being processed through a blooming mill and two finishing mills without re-heating. This is particularly true of joist and small wide flange sections rolled from this ingot.

Member: Would you tell me what your soaking period would be?

J. R. Chegwidden: In this experiment, we aimed at a drawn temperature of 2340 F, with the temperature at A (Figure 2) representing the inside temperature of the ingot, and being the control point for point of draw. In three cases the inside temperature and pit temperature came up to draw temperature almost simultaneously, in others, the pit temperature was brought up to 2400 F, and coke gas shut off until pit cooled to approximately 2340 F. Soaking times varied from 5 to 15 minutes for this experiment.

H. Northrup: Have you noticed in this experiment, or other experiments that you have run into any correlation between this track time and the condition of the bloom surface as far as surface defects?

J. R. Chegwidden: In this low carbon grade of steel, we have observed no appreciable correlation between bloom surface and track time except in those cases where the proper heating procedures through the soaking pits have not been strictly adhered to for long track time heats. There is a correlation, however, in most other grades of steel.

Plan to Attend

1952 ANNUAL AISE CONVENTION

AND

IRON AND STEEL EXPOSITION

CLEVELAND PUBLIC AUDITORIUM

CLEVELAND, OHIO

SEPTEMBER 30, OCTOBER 1, 2 AND 3

A NEW SLAB SHEAR AT ROTARY ELECTRIC STEEL CO.

By E. T. PETERSON
Vice President-Engineering
Birdsboro Steel Foundry & Machine Co.
Birdsboro, Pa.

. . . . the new shear described gives positive control of slab, eliminates depressing table and shock on shear table, and features quick release of the sheared off portion of the slab . . . .

▲THE standard down cut slab shear is a familiar sight to all steel men, as are the difficulties encountered in its operation. Figure 1 illustrates such a shear diagrammatically, showing the slab in position ready to be cut, and the depressing table in back of the shear for receiving the sheared slab.

Figure 2 shows this type of shear making its cut. Since the depressing table is operated by separate drive, or else is connected to the moving ram, it is apparent that this table must drop an amount at least equivalent to the thickest piece for which the shear is designed, in order to provide clearance for the sheared slab. When the slab being sheared is actually less than maximum thickness, the sheared piece is permitted to fall on the depressing table, a distance equivalent to the difference between the maximum and the actual thickness. These tables are at best comparatively complicated and fragile compared with stationary tables, and the repeated shock of the falling slab makes them the subject of considerable maintenance.

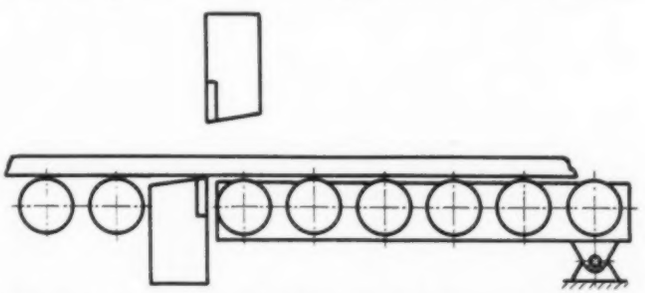
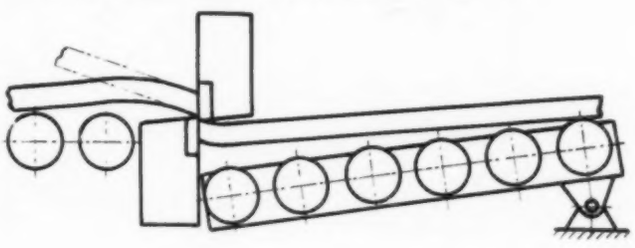


Figure 1 — Diagrammatic sketch of standard down cut slab shear in position ready to cut.

Figure 2 — Standard down cut slab shear has depressing table which must drop for cut to be made.



In addition, as the piece from which slabs are being cut becomes shorter, it is lifted in the air by the action of the shear, as shown by the broken line in Figure 2, and after it is sheared off, drops again on the shear approach table, also punishing this table severely.

Worst of all, the same action which causes the back end of the piece to be lifted in the air also causes an "S" curve to be put in it before it is actually parted, leaving bent ends on the sheared slabs. Further, since the piece is not perpendicular to the shearing plane at the time of shearing, an oblique cut is obtained rather than a square one.

In order to avoid the turned down end and the oblique cut, as well as the punishment of the shear approach table which results when the piece being sheared is not tightly held, some shears have been provided with hold down gags. However, these gags have mostly been mounted in a fixed manner on the top knife slide, and, therefore, they must be adjusted for each thickness of slab. If they are set too high they are ineffective, and if left too low when thickness is increased, they may be wrecked. As a result, the shear operators very often may have them fully retracted, and they are not operative a large part of the time.

A recent down cut shear, shown diagrammatically in Figure 3 features a hydraulically operated hold down which automatically adjusts itself to the thickness of the slab, and at the same time controls the operation of the depressing table and adjusts its stroke automatically to the thickness of the slab. The cutting operation of this shear is shown in Figure 4, with the gag holding the uncut slab firmly in position on the bottom knife anvil, and the depressing table lowered just the proper distance to accommodate the sheared slab. The

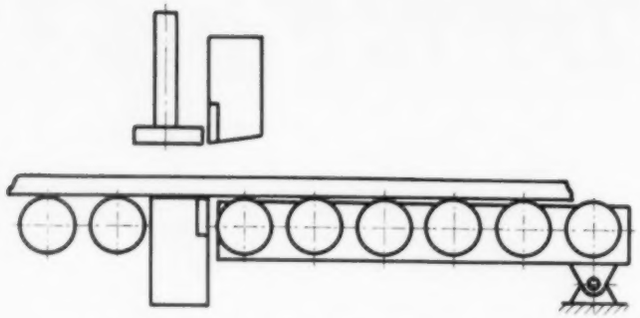
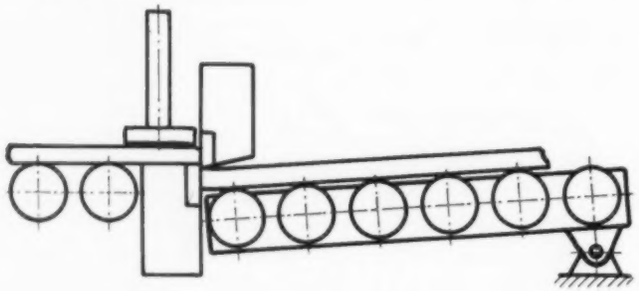


Figure 3 — This down cut shear features a hydraulically operated hold down.

Figure 4 — The gag holds the uncut slab in position on the bottom knife anvil.



hold down gag exerts a substantial pressure, and prevents turn down of the sheared end and lifting of the unsheared slab. Figure 5 is a close-up view of this shear showing the gag arrangement.

In order to eliminate the troublesome depressing table, the up-cut or side-cut shear may be used. The up-cut shear, shown diagrammatically in Figure 6, has a considerable disadvantage, in that the piece must be lifted clear of the table up against the top stationary knife, causing distortion and severe shock on both approach and runout table when the sheared slabs fall down after being parted. The side cut shear, shown diagrammatically in Figure 7, consumes a great deal of space, is not practical for wide slabs, and for shearing any slabs at all it is necessary to provide a turn-up device to turn the slabs on edge before shearing, after which they must be turned back on their flat side.

The up-and-down-cut shear has been developed to eliminate the depressing table, without any of the disadvantages of the up-cut and side-cut shears mentioned above. The operation of such a shear, of conventional design, is shown in the following illustrations.

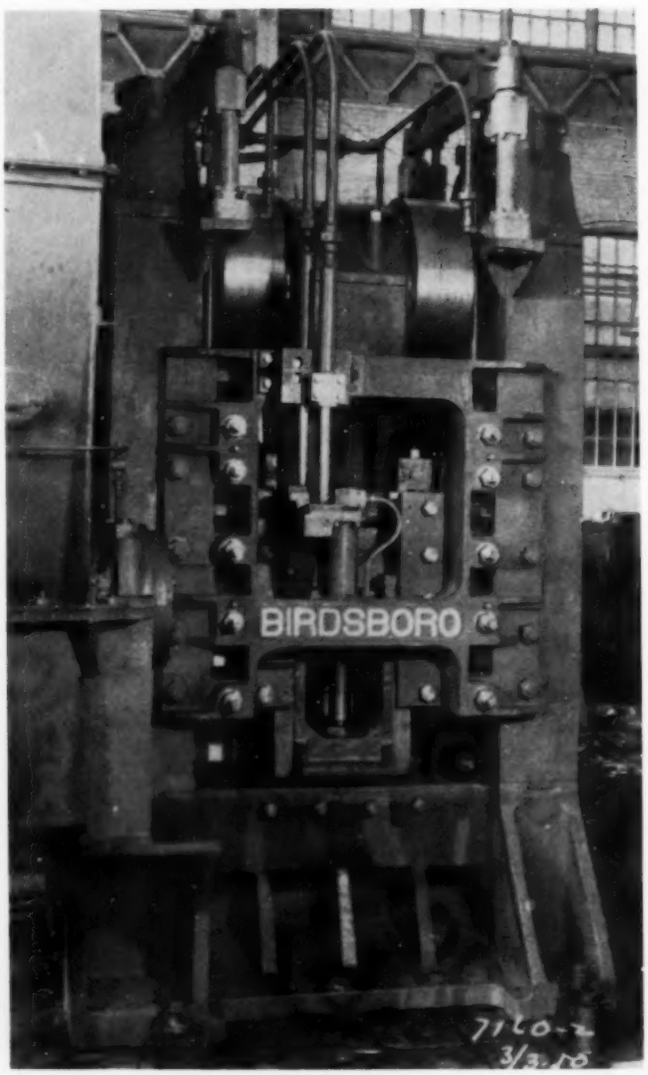
Figure 8 shows the shear in open position with the piece between the shear knives ready for shearing. As the shear starts its cycle the top knife slide comes down until it engages the piece, as shown in Figure 9, at which time the weight of the moving parts of the shear is transmitted through the piece to the roller tables, as well as the shock of stopping the top knife slide and accelerating the bottom slide instantaneously. Since the bottom knife slide, and any anvil which may be provided, must be somewhat below the roller level to permit the piece to be delivered into the shear without sticking, the weight and the shock mentioned above cause the bar to be bent as shown in Figure 10 where the bottom knife slide has started to rise.

As the lower knife continues to rise, the shearing action proceeds, as shown in Figure 11, giving much the same results as with a down-cut shear, the principal advantage being merely that the depressing table is avoided.

In Figure 12 the shear is shown as the lower knife returns to its position. In the meantime, however, the piece which has been cut off is held against the table by the top knife, and cannot be moved beyond the gage until the top knife lifts, as shown in Figure 13. Not only delay is experienced at this point, but also considerable wear on the table mechanism, since the operator often starts the table up immediately to remove the sheared slab at the earliest possible moment, and thus the table must slip against the slab and the weight of the shear moving parts, until the piece is released by the lift of the top knife slide.

A further disadvantage of all the different types of shears described above, is that the throat where the cutting action takes place is enclosed on both sides by the shear frame. This condition makes it difficult for the operator to see in spotting the slab for shearing crops; it also enhances the difficulties of removing crops and slivers which may become lodged in the shear throat, or which may be too short to be moved by the mill tables. The inspection, changing, and setting of the

Figure 5 — Closeup view of down cut shear with hydraulic hold down.



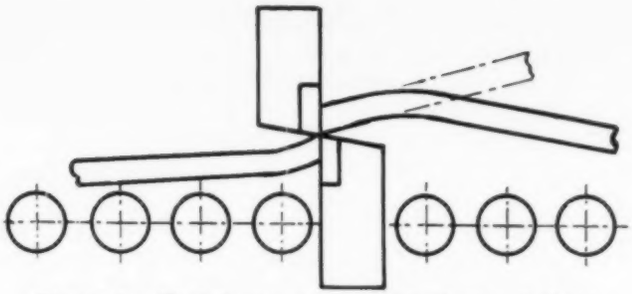


Figure 6 — Sketch shows operation of up cut shear.

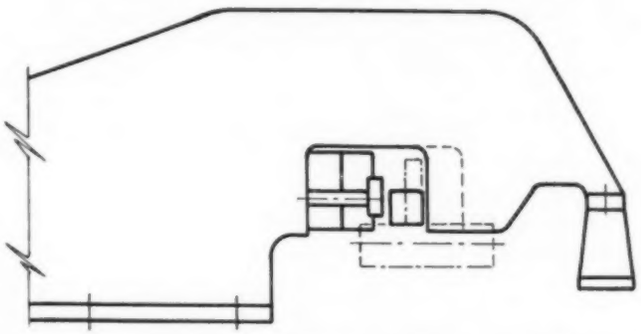


Figure 7 — Bottom shows side elevation of side cut shear with overhead frame. Upper sketch is plan view of same shear.

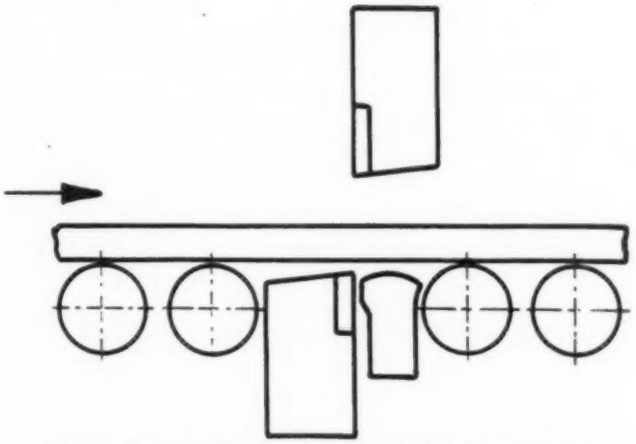
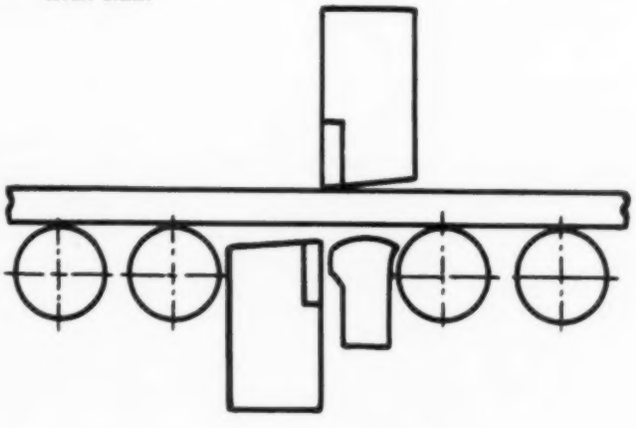


Figure 8 — Conventional up-and-down cut shear.

Figure 9 — Top knife has come down and is in contact with slab.



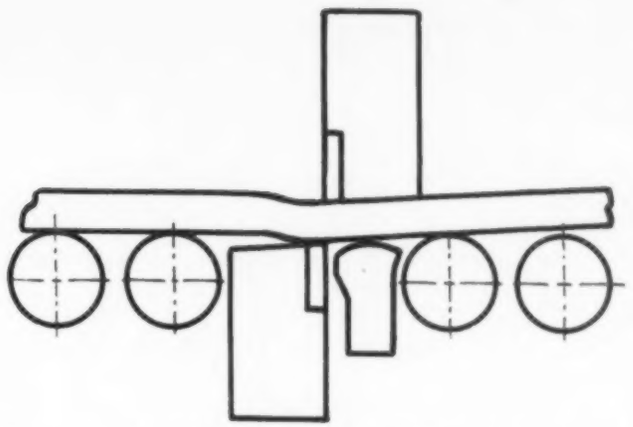


Figure 10 — In this view bottom knife is just starting to rise.

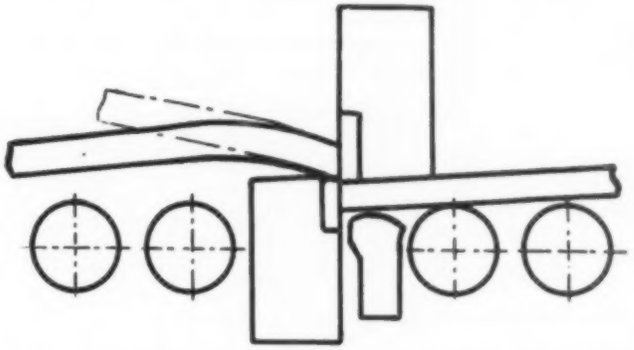


Figure 11 — Bottom knife has risen sufficiently to shear off slab.

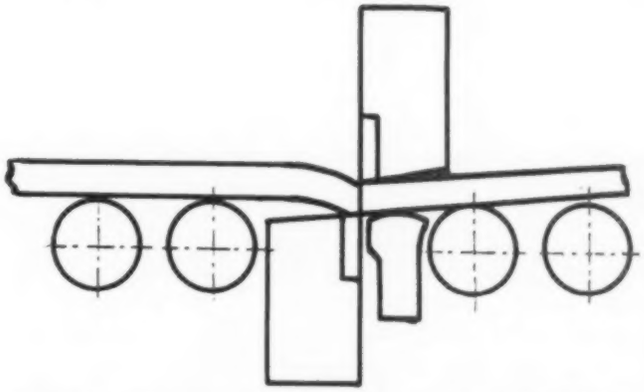
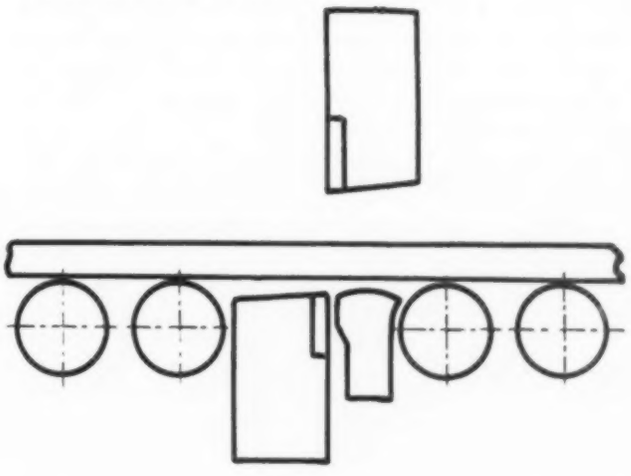


Figure 12 — Bottom knife has now returned to its position.

Figure 13 — Top knife has risen to its original position and new slab is in place.



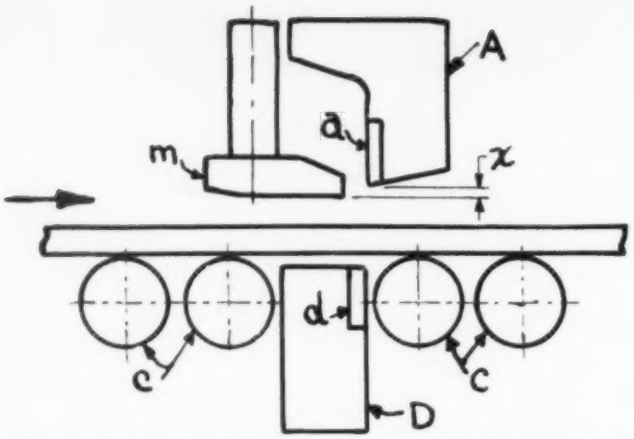
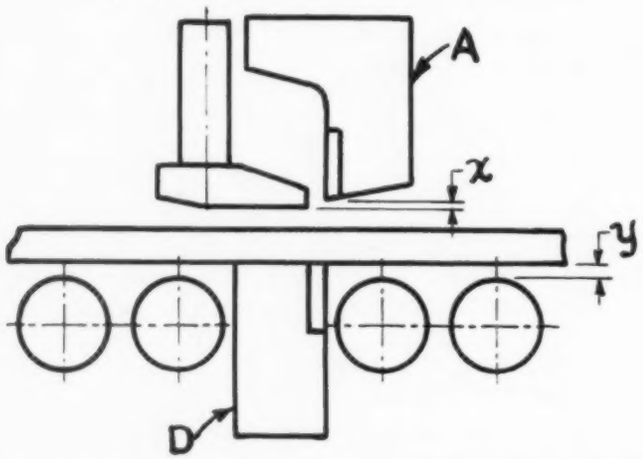


Figure 14 — Schematic view of new type slab shear.

Figure 15 — Shearing cycle is started as bottom knife rises to lift slab a slight distance.



shear knives is also made difficult by this enclosed arrangement.

In order to avoid the various difficulties with conventional shearing equipment, discussed above, there has been developed by a machinery company in Dusseldorf, Germany, an open side up-and-down-cut shear, which is now manufactured in this country; an installation of which has recently been made at the plant of the Rotary Electric Steel Co., as part of their new 36 in. blooming mill equipment.

The operation of this shear is indicated diagrammatically in the following series of figures.

Figure 14 shows the shear with the slab in place for cutting. The lower knife slide "D" is retracted slightly below the level of the roller tables, to avoid interference with the incoming slab. The upper knife slide "A" is at its top position with the heavy hold down gag "M" a short distance "X" below it.

In Figure 15, the shearing cycle has been initiated with the lifting of the bottom knife slide through a small distance, in order to lift the slab a distance "Y" off the table rollers, and thus to prevent any part of the cutting action or weight of the shear parts from coming against these rollers.

In Figure 16 the top knife slide, with the hold down gag always leading it by a distance "X," has come down towards the slab to the point shown, at which point the gag clamps the slab firmly to the bottom knife slide. At this point the gag and the bottom knife slide carrying the slab between them start to move upwards, while the top knife remains stationary.

In Figure 17 this motion has brought the slab into contact with the top knife slide. The movement continues until the shearing action is completed as shown in Figure 18. The bottom knife slide and gag always rise an amount sufficient for the knife blades to close, no matter what thickness of slab is being handled, and the slab, being clamped firmly between the hold down gag and the bottom shear slide, is always held perpendicular to the shearing plane, eliminating turn down of the sheared end and making a square cut. At this point, also, the sheared-off portion of the slab has clearance represented by X plus Y, which is a small fraction of an inch, between the top knife and the roller table, and is free, therefore, to be carried away immediately by the roller table. Thus time is gained in clearing the shear gage, so that the uncut slab can be fed forward, immediately after the shear knives are open.

In Figure 19 the bottom knife slide and gag have returned the uncut portion of the slab to a very small distance "Y" above the roller table, at the same time removing any slight bend which may have been put in it during the cutting stroke.

At this point the gag releases the slab, the bottom knife slide returns to its position below the lower table

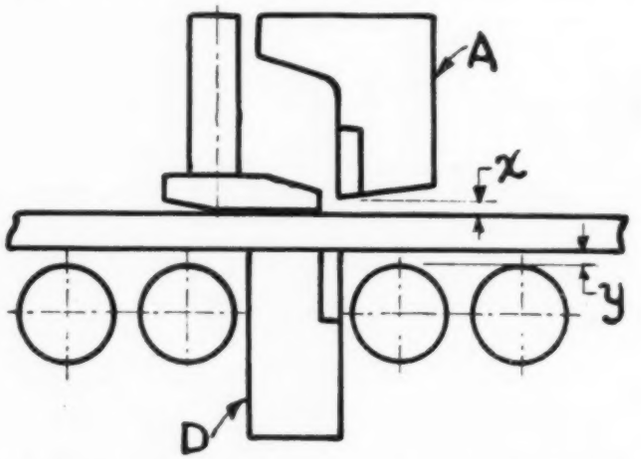
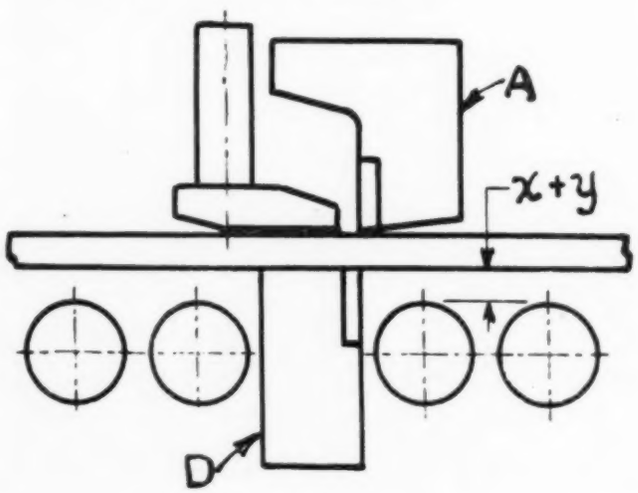


Figure 16 — Hold down gag has now come down to clamp slab.

Figure 17 — Hold down gag and knife has risen and brought the slab in contact with the top knife.



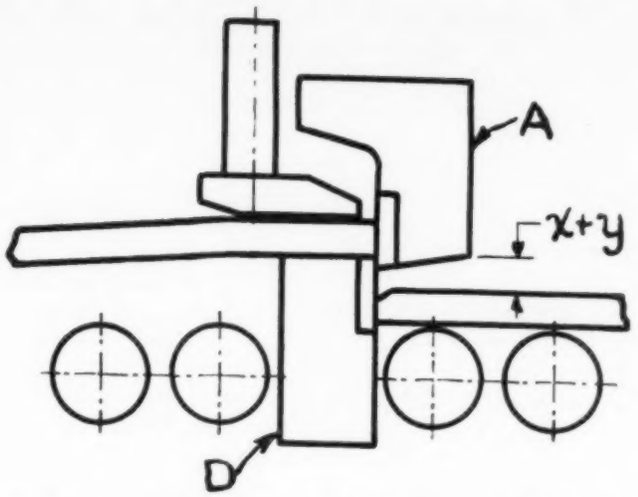
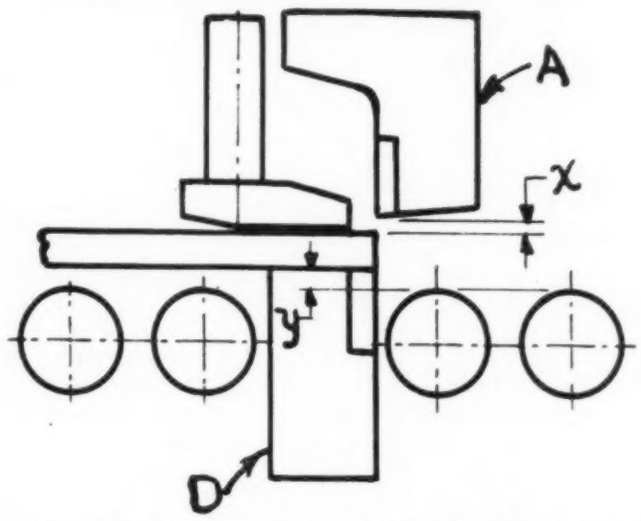


Figure 18 — Shearing action has been completed in this sketch.

Figure 19 — Gag and bottom knife have now returned the uncut slab practically down to the roller table.



rollers, and the unsheared portion of the slab is fed forward into the shear, as shown in Figure 20.

The elements of the operating linkage are shown in Figure 21. The entire shearing cycle takes place in one revolution of the main crank "T." The initial lift of the bottom knife slide is accomplished by cam "S" operating on cam roller "A" through link "P" and lever "N." As the crank shaft continues to rotate, the throw of the crank pulls on connecting rod "H," causing the bell crank "F" to rotate about pivot "G." The motion of this bell crank lowers the top knife slide "A" and gag "M" until the gag meets resistance from a slab. Thereafter the continued rotation of the bell crank about its pivot in the upper knife slide causes the lower knife slide "D," and the gag "M" to rise. As the crank completes its cycle, connecting rod "H" moves forward, the bell crank "F" returns to its original position, lowering the bottom knife slide and the gag, and eventually lifting the top knife slide "A" and the gag "M" to their original positions. The cam "S" has meanwhile permitted cam roller "A" to lift to its original position, but an expanding shock absorber device in link "P" causes it to hold lever "N" in such position as to receive the weight of the lower knife slide and lower it gently until the lever foot rests on the stop shown.

It is also to be noted that the shear frame is subjected to compressive loads only, making it substantially immune to overload. Hot shears, possibly more than any other steel mill equipment, are liable to heavy overloads, due to the introduction of oversize or cold material. Conventional shears are sometimes equipped with overload protection devices, such as shear pins, but these devices are more noted for their unreliability than otherwise. Since the shearing load, in shears other than the up-and-down-cut type, produces tensile stress in the frame, these machines are always subject to the ultimate catastrophe in shear operation, a broken frame. While this shear can be broken, like any other machine, it will not suffer a broken frame as a result of shearing overload.

Figure 22 is a general view of the installation at the plant of the Rotary Electric Steel Co. The operator's pulpit is placed in front of the shear, somewhat behind the knives, affording maximum visibility for setting the slab to cut crops. A drop end is provided on the

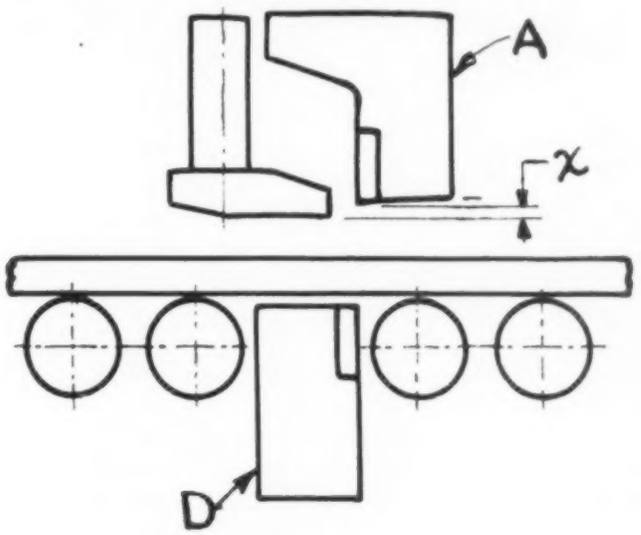
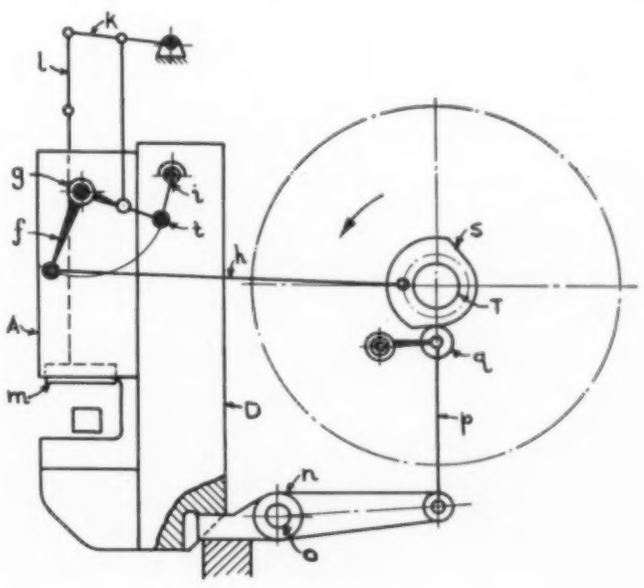


Figure 20 — Gag has now released the slab and the bottom knife is below the table rollers.

Figure 21 — Sketch shows elements of operating linkage.



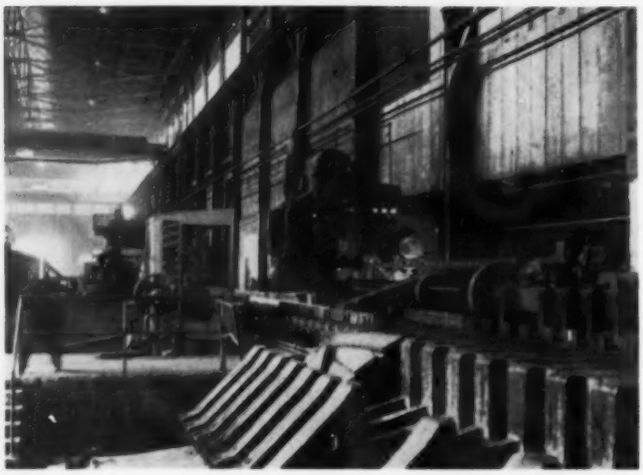
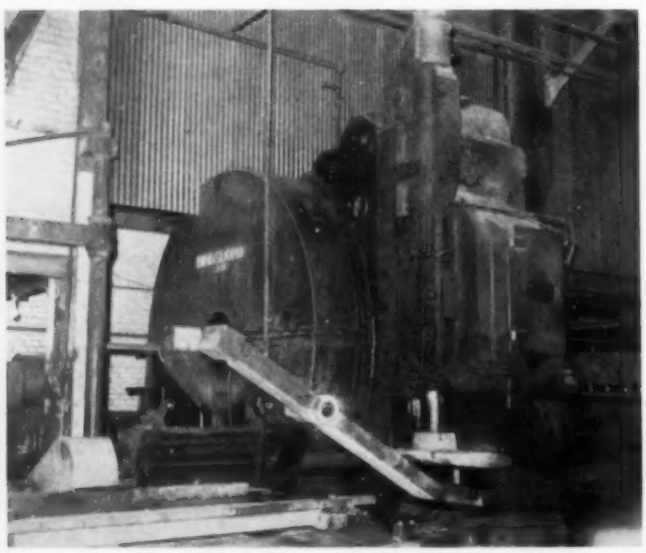


Figure 22 — General view of new slab shear installation at Rotary Electric Steel Co.

shear runout table, to permit crops to fall into a crop bucket located below the floor in back of the operator's pulpit. Figure 23 is a front view of the shear, showing crop pusher mounted on the left side of the shear to push the back end crop across the lower knife slide into the crop pit. This device permits the removal of the back end crop from the lower knife blade immediately after shearing, avoiding any effects which the heat from this crop might have on the lower knife blade. It also permits shearing of the rear crop while hot, in case this crop is long enough to require cutting. Both the lower and upper knife slide are cooled internally by circulating water, to prevent overheating under severe operating conditions.

The shear at Rotary is of 700 tons capacity, and is designed to cut 12 × 12 in. blooms and slabs 40 in. wide × 3½ in. thick. It is driven by two d-c motors operated from a variable voltage motor-generator set, and these motors start and stop for each cycle. The drive has a clutch device by which two different reduction ratios may be secured, giving 17 cuts per minute when cutting small slabs or blooms and 7 cuts per minute when cutting the larger sizes, based on rated full load motor speed of 840 rpm. Because of the size of this shear, the gear drive and motors are located in back of the shear. On smaller shears of this type, a-c drive may be used with clutch and brake. On these smaller shears the motor, flywheel, and gearing are all carried on the shear frame, making a very compact arrangement.

Figure 23 — Closeup view of shear at Rotary Electric Steel Co.



It will be understood that the remarks in this paper apply equally to the shearing of blooms and billets as well as slabs, and that where slabs are mentioned, blooms and billets can also be applied.

In closing, it is appropriate to summarize the advantages available with shears of this type, all of which are not found in any other type, although some of the features may be found in shears of conventional design.

1. Positive control of the slab by a heavy hold down gag, preventing turned down ends and oblique cuts.
2. Elimination of depressing table in back of the shear.
3. Quick release of sheared off portion of the slab, facilitating gage operation.
4. Elimination of all shock on shear tables.
5. Unobstructed view and access to shear throat.
6. Shear frame subjected to compressive loads only.

Installation of this shear by Rotary was a significant step in their program of providing their plant with the most efficient equipment throughout.

DISCUSSION

PRESENTED BY

T. C. MAYBERRY, General Superintendent, Great Lakes Steel Corp., Ecorse, Mich.

C. P. HAMMOND, Superintendent Rolling Mills, Rotary Electric Steel Co., Detroit, Mich.

F. H. ROWE, JR., Expediter, Great Lakes Steel Corp., Ecorse, Mich.

E. T. PETERSON, Vice President-Engineering, Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.

Member: This certainly is a novel design. The mechanical part is the most ingenious mechanical device I have ever seen, and it is certainly doing a job, except when you try to cut cold steel with it—then it does not do so well. That shear, is a start and stop proposition, no clutch, and driven with 200-hp, d-c motors, each having a supporting generator. The shear is designed so that it will make seventeen cuts per minute, start and stop.

Two hundred and fifty horsepower motors have to accelerate and cut the slab or block in one revolution. We are operating it now with one 250-hp motor, and it seems as though it is over-powered. We do not know what it would need in the way of power if we were cutting short billets where we might need sixteen or seventeen strokes a minute, we might then need the extra horsepower, although I doubt it for the acceleration. The motors are regular mill-type motors, and they are 230 v. Under normal rating, the generators will impress 490 v on the motor in order to accelerate them fast.

We do not know exactly what the shear will do in the final analysis, but it certainly looks good.

T. C. Mayberry: How long does it take to change the knives, and what amount of tonnage can be sheared on a set of knives?

C. P. Hammond: In regard to the shear knives, we do not have much experience on this particular shear, however on four edges we did cut a hundred thousand tons. We were not entirely satisfied with that and are trying another type of shear blade.

As far as changing the blades is concerned, you can readily see they are easier to change on this design of shear, even though they are large, because you can swing them up with a crane, and slide them in easily. It takes about one hour to change them.

The shear is a very smooth operating shear and it makes a square cut, it also does an excellent job of keeping the billets or slabs straight.

F. Rowe: Mr. Peterson mentioned that when or after the bar is cut the slab does not drop on the delivery table; does the bottom knife travel up the thickness of the slab or more than the thickness of the slab in relation to the top knife?

E. T. Peterson: The cutting action takes place after the slab is initially lifted a short distance off of the roller table. That situation is obtained through the cam action which I described. Therefore, when the top knife and the gag meet the bar, they meet it with the bar located somewhat above the roller table, and the top knife does not move from that point on, but that clearance is maintained, so that when the cutting action is completed, that clearance enables the sheared bar to run out freely. The bottom knife travels up slightly more than the thickness of the slab, parting it, and then returns to table level, cutting the slab clamped to its top surface by the gag.

CURRENT AISE DISTRICT SECTION MEETING NOTICES

BIRMINGHAM SECTION

Monday, January 28, 1952 — Dinner 6:30 P.M., Meeting 8:00 P.M.

"Carbon Brushes on Steel Mill Equipment" by J. S. Ahrens, Manager, Brush Department, National Carbon Division, Union Carbide & Carbon Corp., Cleveland, Ohio.

Thomas Jefferson Hotel, Birmingham, Ala.

▲

BUFFALO SECTION

Tuesday, January 8, 1952 — Dinner 6:30 P.M., Meeting 8:00 P.M.

INSPECTION TRIP — Ford Motor Co. Stamping Plant, Town of Hamburg, N. Y.

"Operations at Ford Stamping Plant" by A. J. Hole, Plant Manager, Buffalo Stamping Plant, Ford Motor Co., Hamburg, N. Y.

Dinner and Meeting — Ford Plant Cafeteria

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CHICAGO SECTION

Wednesday, January 9, 1952 — Dinner 6:15 P.M., Meeting 7:45 P.M.

"Regulating Systems for the Steel Industry" by W. R. Harris, Manager Metal Working Section, Industry Engineering Department, Westinghouse Electric Corp., East Pittsburgh Pa.

Phil Smidt's Restaurant, 1205 North Calumet Ave., Hammond, Ind.

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CLEVELAND SECTION

Monday, January 21, 1952 at Cleveland, Ohio — Dinner 6:30 P.M., Meeting 8:00 P.M.

Tuesday, January 22, 1952 at Youngstown, Ohio — Dinner 6:30 P.M., Meeting 8:00 P.M.

"Fundamentals of Processing Magnetic Taconite" by Dr. E. W. Davis, Mine Experimental Station, University of Minnesota, Minneapolis, Minn.

Cleveland — Allerton Hotel, Cleveland, Ohio

Youngstown — El Rio Club, Youngstown — Warren Rd., Route 422, Youngstown, Ohio.

▲

DETROIT SECTION

Tuesday, January 8, 1952 — Dinner 6:30 P.M., Dinner 8:00 P.M.

"Industrial Relations" by Jas. K. Sutherland, General Manager, Steel Division, Ford Motor Co., Detroit, Mich.

Rotunda Building, Ford Motor Co., Schaefer Road, Detroit, Mich.

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PHILADELPHIA SECTION

Saturday, January 5, 1952 — Dinner 6:00 P.M., Meeting 7:00 P.M.

OLD TIMERS NIGHT

"Basic Factors in Electrolytic Corrosion" by Dr. E. S. Wolf, Superintendent, Electrical Test Department, Consolidated Gas Electric Light and Power Co. of Baltimore, Baltimore, Md.

Engineers Club, 1317 Spruce St., Philadelphia, Pa.

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PITTSBURGH SECTION

Monday, January 14, 1952 — Dinner 7:00 P.M., Meeting 8:00 P.M.

"Continuous Annealing of Tinplate" by M. D. Stone, Manager of Development and E. A. Randish, Research Engineer, United Engineering and Foundry Co., Pittsburgh, Pa.

University Club, University Place, Pittsburgh, Pa.

HANDLING AND STORAGE OF ELECTRICAL PARTS

By A. W. McAULY
Chief Electrical Engineer
Edgewater Steel Co.
Oakmont, Pa.

. . . . it is essential that spare parts be stored so that they can be easily found and taken out of storage if down-time is to be kept to a minimum . . . .

▲ THE primary purpose of the electrical maintenance crews of any industrial plant is to see to it that production machinery does not fail in service any oftener, or for periods longer, than can by any reasonable means be reduced. In this effort, a large factor is the provision of spare units, which may be quickly installed to replace a defective part, thus restoring a machine to service much sooner than would be the case if repairs were made on the job. Another factor fully as important, is the development of methods calculated to reduce this replacement time to a minimum, consistent with safety. It follows that the electrical department of a steel mill is bound to accumulate a large number of various items of spare parts for the equipment under its supervision.

These parts range all of the way from complete motors and controllers of various sizes, to the smallest of instrument parts. They also include castings and forgings of various shapes and sizes for electric crane and charger repairs. Sometimes the electrical department also maintains such items as pinions and gears, belt drives, chain drives, mechanical couplings, complete blowers, fans, and gear reducers. In order to reduce delays caused by breakdown of production machinery, replacement parts such as armatures, bearings, resistors, motor and control parts, cables, trolley wires, collector slides, brushes, etc., must be instantly available in a wide variety of sizes.

Most of these items are supposed to be kept in a warehouse or storeroom, subject to regular inventory and replacement, as shop orders reduce the stock. From the standpoint of accuracy of accounting this system is desirable. In actual practice, however, this storeroom service is sometimes too slow to allow speedy restoration of equipment to service after breakdown, so the storeroom service is often supplemented by a stock of items ordered out ahead of breakdowns, and kept in various places according to the ideas of the maintenance crews. This supplementary stock is stored in cupboards and lockers or otherwise placed where it is not easy to locate, even by the men who put it away. That is a disadvantage. The main advantage is that spare parts can be made available without any need for the repairman to bother with orders or records. Now this system would be workable if we could eliminate the disadvantages. Admittedly, some sacrifice in accounting accuracy must be made, but it probably exists anyway, possibly in greater degree than realized. Once the decision is made to carry a stock of parts in the shop, the problem of how and where to store them must be settled. A few general principles must be adopted at the outset.

Figure 1 — One of the features of this shop is the efficient manner in which the aisles are kept clear.

First, all parts must be in plain sight—instantly available without disturbing any other part. This is quite a large order, but it can be done, provided of course that space is available. In many cases, only one part need be kept on hand. It calls for a regular place to keep the part, designed especially for that part, not piled on the floor or parked away out of sight, but resting in a hanger on a shelf or bracket made for the purpose. Vertical space must be used as far as possible also. Slanting the shelves helps to keep the parts visible. Once planned and properly arranged, it becomes easy to keep these parts in place, and to replace them as vacant spaces appear.

Second, suitable handling facilities for the heavy parts must be provided both for lifting and transporting material that is too heavy to carry. Since there are objects of various sizes and weights to handle, vehicles of various sizes and shapes will be needed. These call for smooth runways over which these vehicles roll. The shop floor should be hard and smooth. Aisles should be provided between departments over which loads may be wheeled. For heavy pieces or for long distances, power trucks may have to be used, but loads up to several hundred pounds may be easily and safely

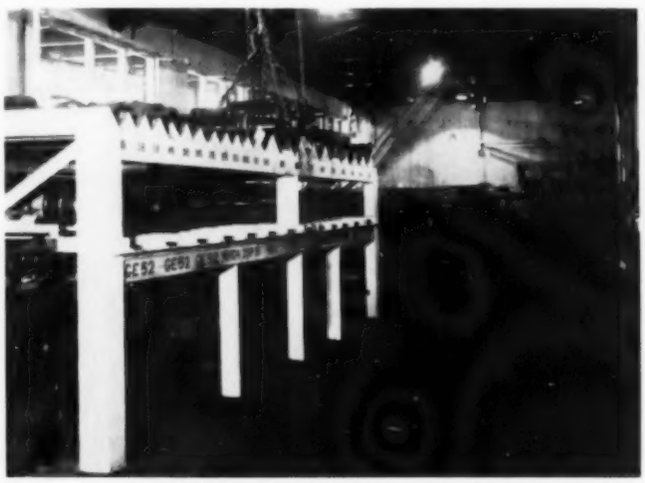


Figure 2 — Material in the top armature rack is handled by an overhead hoist.

wheeled along a smooth hard surface if the proper vehicle is used. With reasonably smooth runways, smaller wheels may be used which keeps the material near the floor. This makes it easier and safer to handle. Inexpensive metal wheels may be used if the surface is good.

Third, material should be classified and stored in a particular location. The shop should be divided into specific zones, and these zones should be numbered or otherwise identified, and a catalog made up, listing the classes of material together with its zone location number. With the classes arranged alphabetically in the catalog, the man who is looking for certain material can easily locate it, and conversely, the man with a piece of material to dispose of will know where it is to be stored. Use a red tag on "Bad order" material, a white tag after repairs have been made. Many small articles, such as controller segments may be stored within sight, and enough kept on hand by visual inventory and replace-

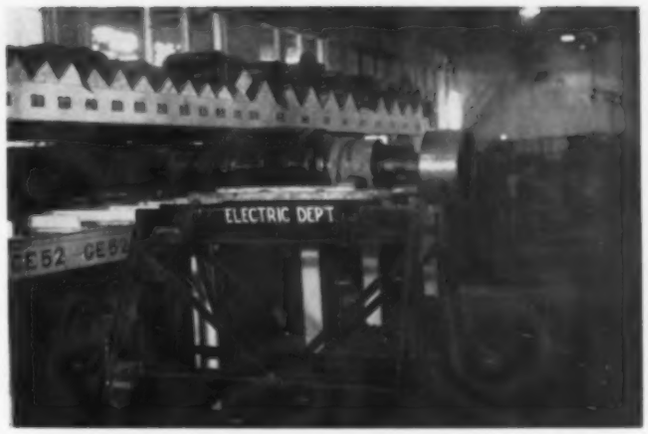


Figure 3 — Material in the second rack is shoved onto a portable carrier.

ment to take care of the demand. A convenient device for this purpose is a rotary pylon, to be described later.

As material is used, new material may be ordered out of the storeroom, and charged to the equipment where this material is ordinarily used. This method is not as inaccurate as it may seem. There is a lag between the time when any specific item is taken from the stockroom and its actual use, but averaged over a long period of time the movement of material and the requisitions for the material tend to follow quite well. Any change in kind of material used for a particular job will be reported to the storeroom promptly because the shop man in charge of housekeeping will be familiar with such changes.

Fourth, storage space should not be used as working space, or vice-versa. The working spaces should be occupied by only material in the process of repair. Floors, workbenches, and especially aisles, should be clear so that workmen may move freely from one place to another within the working zone. See Figure 1. The storage area may have to be somewhat more congested in order to save space, but if careful planning is done when stored material is considered, it is often possible by making use of vertical space, to develop considerable additional space. Unless correct habits are formed,

Figure 4 — The armature buggy shown here is easy for one man to push.

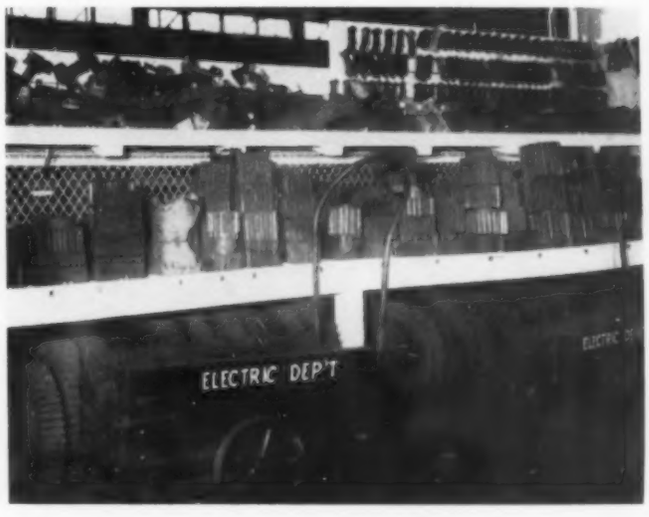
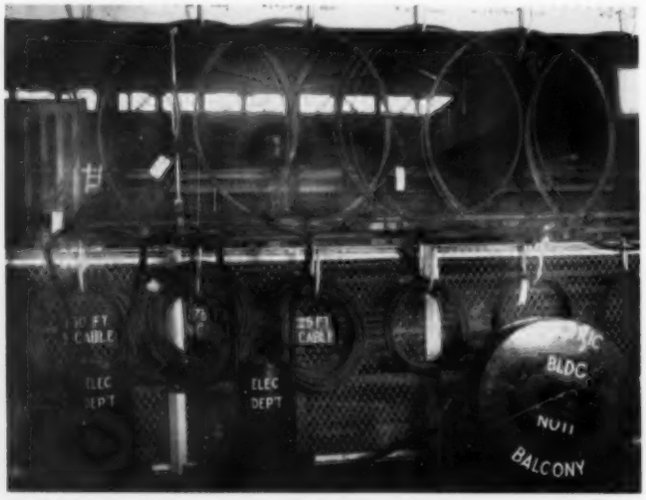


Figure 5 — Bolts are stored in the bolt cabinet.

material will naturally be piled without much regard for safety or space saving. Parts should be arranged parallel to each other and if "nesting" is possible it will develop considerable space. If material is arranged carefully, several advantages will be gained. Space will be increased. There will be fewer accidents. Less time will be lost hunting for material. There will be shorter delays to equipment when breakdowns occur. There will be less breakage or other damage to material. Costs will be lower. Morale will be improved.

Perhaps one of the most difficult problems of storage of spare parts is that of storing armatures, so that each one may be brought out in a short time, and without injury to armature or man with a minimum of help. To do this they must be stored in such a manner that there is no interference between them during handling process. Armatures vary greatly in size, shape and weight, and this fact makes their storage in one rack somewhat difficult. One of the early designs of armature storage rack was an upright framework structure somewhat resembling a pyramid wide enough at the bottom to take the shafts of the longest armatures and tapering in at the top to take the shorter ones.

Figure 6 — Steel hoists and cable are available for immediate use.



There were two disadvantages to this type of rack. The lower armatures rested in hooks or brackets, and to save space, had to be located somewhat under those above which made it difficult to get the lower ones out. Also, this type of rack, if many armatures were to be stored, had to be rather high, which made it difficult to reach the ones on top. Another type rack was the double deck type with the larger armatures stored on top where they were easy to lift out, but in order to save space, the medium and small sizes were stored on the lower deck, which made it very difficult and unsafe to get them out.

It is desirable to conserve space as much as possible. It is also necessary to conserve man-power. Safety in handling should also be assured. The rack to be described measures 5 ft by 15 ft, with three decks, and one man can safely and quickly bring out any armature. It will accommodate perhaps 50 or more armatures ranging in size from 100 hp to fractional hp. (Figures 2 and 3). The first requirement is a cement floor, or other smooth hard level surface, to take the rack, with a runway of the same surface, at the same level, from the rack to the point where the armature is to be handled by crane or tackle as the case may be. The second requirement is a vehicle suitable for safely carrying an armature, regardless of its size and that without any need for adjustment for size. This armature buggy should be designed to protect the windings and commutator while in transit, and should be easy for one man to push (Figure 4). The third requirement is an overhead beam or jib equipped with a hoist and so located as to sweep over the top deck and adjoining space. Each of the larger and medium sized armatures is stored in a cradle designed to take a particular armature. These cradles are made of wood, in the case of the largest armatures, and of sheet steel in the medium sizes. All cradles are fitted with four ball bearing casters for easy movement. Two of the casters on the large cradles are of the swivel type so that the cradles may be rolled in any direction. The cradles which are stored on the center deck are fastened so that the cradle will roll only in a straight line.

The larger armatures are simply rolled out from under the second deck when needed and wheeled out beneath an overhead crane which places it in a transport truck for conveying to the particular part of the plant where the replacement is to be made. (Figure 2).

In the case of armatures on the second deck, a portable carrier has been designed to match up with the angle rails upon which the cradles rest with their armatures in place. A locking device attaches the carrier to the rack while the armature is being run out or in, thus preventing the carrier moving away from the rack and perhaps dropping the armature (Figure 3). The carrier can be easily pushed along to a point underneath an overhead crane in the same manner as the larger cradles. Or the armature may be lifted from the carrier by the shop hoist and placed in the armature buggy referred to above, which can then be rolled along sidewalks or other smooth floor to the point of use. The two main wheels on this armature buggy are metal, about 10 in. in diam and are located on a shaft placed at the approximate center of the vehicle. Smaller swivel type wheels mounted somewhat higher than the main wheels, and

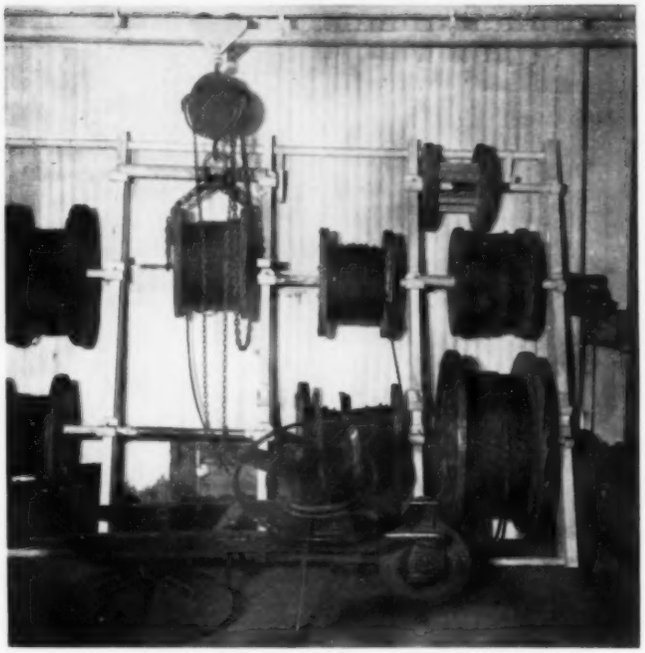


Figure 7 — The collapsible type winding reel keeps the inside diameter at the correct size.

placed under each end, prevent the ends of the buggy from dropping downward far enough to spill the armature, which rests in a V-block made of wood lined with leather belting. A groove in the bottom of the V allows small objects to rest below the armature so that the winding will not be damaged in case small metal particles or parts would get into the V (Figure 4).

Along the top deck of the rack is a series of V blocks of different sizes running crosswise of the rack and covering the whole top deck. In these V's are stored armatures ranging in size from 15 hp to the fractional hp ones as shown in Figure 2. The larger of these armatures must be lifted by the shop hoist, which may be an I-beam crane running the whole length of the shop. The smaller armatures may be lifted by hand. The frame of the rack is made of standard angles fastened together by arc welding. The rails, along which the second deck cradles run, are standard angles with one flange pointed upward as a guide for the cradle casters. The figures show the three ways by which the armatures are handled. A step of openwork grating runs along the back side of the rack at the proper height to allow a man to stand in safety while attaching slings to armature shafts on the top deck. This step is fitted with grab rails at each end for safety. Armatures stored on this rack may be readily examined and bearings or pinions changed without trouble. Since each armature has its own particular location, inventory becomes a simple matter.

If possible, all brake wheels used on a particular armature should be identical. Bridge and hoist brake wheels may then be securely attached to spare armatures which, of course, should carry pinions and bearings. Tapered shafts, using serrations instead of keyways, make the best job from the standpoint of ease of gear and wheel changes but are somewhat expensive.

When a spare armature is used, the defective one comes into the shop and if it is to be repaired in the shop, it is tagged with a red tag, showing where it came from, and it is stored in its regular place until ready to be worked on. After it has been restored to good condition it is tagged with a white O.K. tag. Sometimes armatures are sent to service shops for rewinding, in which case the carrier contains only its bearings, pinion, or other accessories until its return, after which the assembly of the parts restores the whole unit to serviceable condition. All costs in this connection are charged to the job shown on the red repair tag.

Figure 8 — The bearing bins are painted white so that the material can be seen easily.

BOLTS

In addition to their normal service, the overhead cranes in some plants are used for pulling railroad cars, knocking ingots from molds by swinging and bumping, pulling heavy drags sidewise along dirt floors for leveling, and swinging loads from one crane bay to an adjacent bay. Such practices are very hard on cranes. The cables continually cross the cable grooves, jerking the load as the cable again drops into the groove. Trolleys slam into bumpers as wheels slip, imposing terrific impact strains on the whole crane. Strains are sometimes nearly at right angles to the normal direction of design. All this causes breakage and loosening of bolts, and other parts. On older machines, particularly, this sort of maintenance is high.

As a general thing, when bolts or screws are needed for a quick repair job, the procedure is to send a helper to the storeroom with an order for the material. Oftentimes too many are ordered in order to be on the safe side. The excess is thrown into the "junk box." This junk box contains a large number of articles, and from time to time when things are not pressing, a repairman may use some of these "left-overs" after hunting through the pile for some time. Left-over bolts are generally good, and if saved and graded as to size, and stored in such a manner as to be instantly available, can be put into service with a saving of time when really needed. An old core oven or similar device with swing-out shelves may be used, marked for sizes on the front, and the spare bolts sorted as to size, and stored on the shelves where they are easily found. See Figure 5. This system tends to keep miscellaneous bolts from accumulating on benches, floors, and shelves.

In order to make it easier for a helper to select the proper size wrench or bolt, a row of nuts of the various sizes used, are spot welded to a plate on the main tool rack in such a way as to allow a bolt to be screwed into

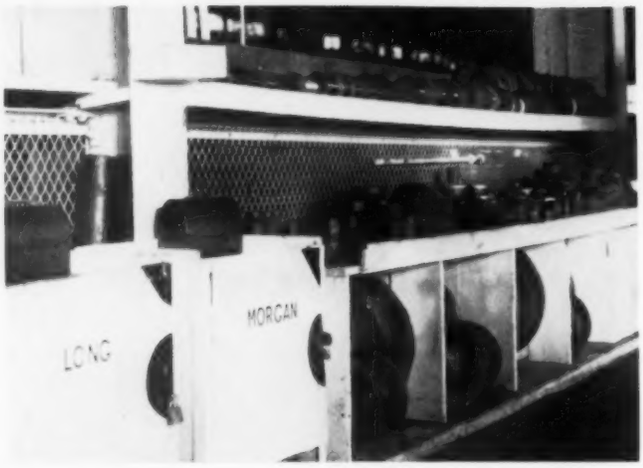


Figure 9 — Bearing rack is shown on the lower shelf and the coils of magnet wire are stored on the upper shelf.

them or a wrench to be tried on them for fit. These sizes are marked opposite each nut.

CABLES

Various sizes and lengths of steel hoisting cable are needed. Much delay can be prevented by having coils of cable of the needed size and length instantly available. See Figure 6. This means that the cable must be ordered from the warehouse or storeroom before it is needed, and stored either at the point of use, or in the shop. Space is a factor in storage problems, but certain forms of material lends itself to storage in a vertical plane. Cable is such a material. It may be wound in coils with a standard inside diameter, to fit the knock-down type "reelbarrow" described below. These coils may then be hung on walls or posts, the heavy coils at the bottom near the floor, and the lighter coils higher up, using a pole hook for those out of reach. The coils should be tagged as to size and length.

The coils are formed by winding the cable on a collapsible type winding reel, to keep the inside diameter correct (Figure 7). The ends are secured to prevent unwinding and to keep the coil tight. A list of the various lengths and sizes should be posted for the guidance of the shop housekeeper who is responsible for keeping the coils made up ahead of the demand for them. When a cable is needed on a crane, the repairman in that part of the plant phones the electric shop and the proper coil of cable is taken from its hook and placed on a "reelbarrow" (Figure 6).

The reelbarrow consists of a metal drum made in two parts which telescope together to form a spool. It is made of sheet steel, strong enough to support a heavy coil of cable while rolling along the floor like a wheelbarrow. A frame is formed of pipe in such a manner as to allow the drum to be raised from the floor, and to support it in free rolling position, after it has been rolled to the point of use. This keeps the cable clean and saves replacement time. The old cable is reeled onto another "reelbarrow" while the new cable is being rolled to the job, and is then brought back to the shop where it is inspected, and parts of it possibly cut into shorter coils for use again. This method of replacing cables saves considerable time when a cable is accidently broken in service and has to be replaced as soon as possible.

Where hoisting cable is removed from storage in random lengths, the reels as shipped should be, if possible, placed upon a rack in such a manner as to allow a length of cable to be removed without kinking. The cable should at all times be kept as clean as possible. Reels as shipped may be stored with a length of pipe running through them, and resting in pockets in the rack beams.

BEARINGS

Many types and sizes of bearings are used and the storage of these constitute a problem. New types are

Figure 10 — Rotary pylons give accessibility at the same time reducing required space.

continually coming in with the newer machinery, while the older types must still be kept on hand. With the older machines, open type sleeve bearings predominate, while at the present time the anti-friction type is more nearly universal. Spares of all types must be kept on hand if serious delays are to be avoided. The larger of the bronze MCB and sleeve types may be stored in open front bins, just large enough to take each size, the bins having been painted white (Figure 8) inside to provide a contrast between the bearing and the bin wall. Small bins should be used for small parts, otherwise disorder will result. (It may be said in passing that white paint should be used generously where artificial lighting has to be used, since the white surfaces greatly increase the lighting efficiency.) Our medium sized, sleeve type motor bearings are stored on a flat shelf about waist high and arranged in rows, graded according to type and size as shown in Figure 9. They are instantly available even to an inexperienced helper. The housings of anti-friction type bearings are also stored on a shelf in similar fashion. Anti-friction bearings are stored on a pylon similar to those carrying coils and control parts shown in Figure 10.

CONTROL PARTS

Control parts are stored on revolving pylons studded with metal pins to allow the parts to be hung in plain

view. The revolving feature takes best advantage of light conditions. The bases of the pylons are on wheels to allow for shifting around for cleaning underneath and to clear the space if needed for emergency work. This is in addition to the revolving feature which makes it possible to easily and slowly rotate the pylon by hand. The reason for this is to save space, since only enough clearance need be allowed between pylons to allow material to pass as they are rotated.

Controllers when brought in for repairs may be placed on a buggy equipped with casters of the heavy duty type. The buggy should be made as low as possible and should have toe boards around its edges to prevent the controller from sliding off the buggy. Most repairs may be easily and safely made without removing the controller from the buggy. After repairs are made, it is stored in a pack with others, each on its individual buggy. A large number can be stored in a small space because any one can be quickly rolled out when needed. See Figure 11.

Drums and finger boards for drum control are stored on a tapered rack, mounted on casters. Each drum has

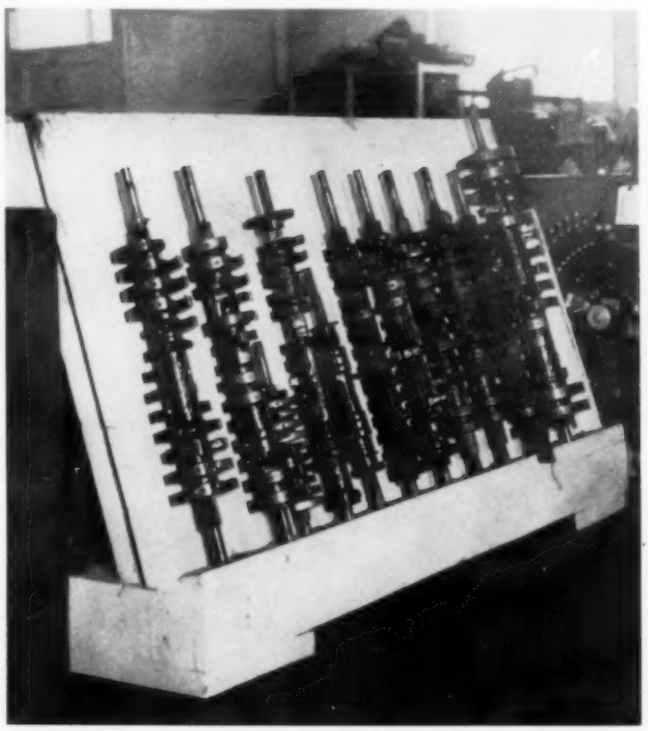


Figure 11 — Controllers are stored as shown on a buggy.

its own stall. Face plates are hung on spikes on a wall (Figure 12).

Coils, if large, are stored in open shelving. If small, they are hung on revolving pylons, the same as controller parts. In the average plant there will be a large number of different coils which must be kept on hand as spares for magnetic starters and controllers. New coils are purchased from nameplate data, or rewound in the shop using the defective coil for a sample. When needed, it is quicker to select the proper coil from a pylon, where the coils are arranged in plain sight and marked carefully to complete the identification, than to get a stock room clerk to select the proper coil from a printed list. For easy identification, of any part for record or re-ordering, use is made of uniform purchase order numbers, in all departments; maintenance, stores, accounting, purchasing, and receiving. The number originates with the storeroom, where the P.O. number is stamped on the original request for the material. Any part properly tagged with one of these numbers may be duplicated with little trouble. This system may apply to all material purchased, whatever its nature.

Gears and shafts, when assembled into spares are stored on the floor, and in racks, and handled by means of an I-beam crane passing over the area. They are transported by means of a push buggy with a V-block to take any size round. The buggy has two main wheels at the center to carry the load, a smaller caster type wheel at each end for safety. The V-block is large enough to take armatures up to 30-hp. Such loads may be easily wheeled along a level walkway, making it unnecessary to halt a production process to use an overhead crane with attendant difficult and unsafe transfers from bay to bay.

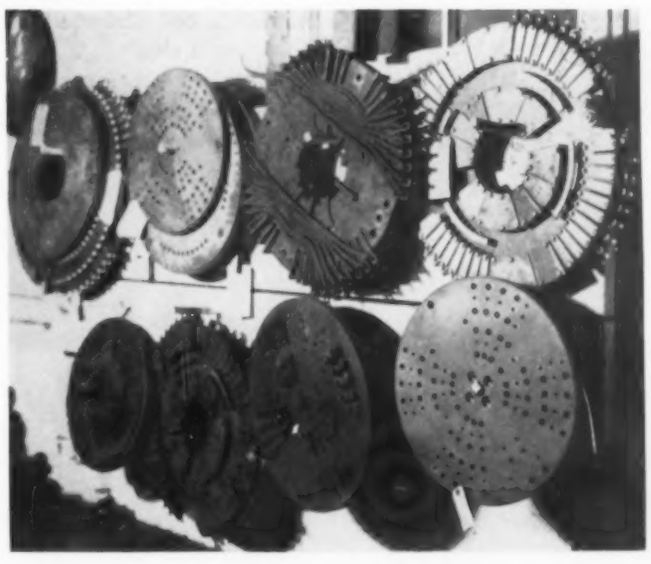
Loose gears are stored on the floor under shelves upon which lighter material is stored. They are rolled in with their edges, or teeth exposed, making it easy to remove any one without disturbing another. They are tagged, showing where they may be used, as shown in Figure 4.

Figure 13 illustrates the general principle that the heavier the object, the nearer to the floor it should be stored. Material that is stored at or above shoulder height should be light enough so that it would not seriously injure a person if it should drop, or strain normally unused muscles, particularly the back muscles or vertebrae. Material stored waist high can be somewhat heavier and still be handled safely. To handle heavy material stored at or near the floor level, a very low vehicle, of the push truck type, should be used for safety.

MOTORS

Complete motors in a variety of sizes, speeds, and voltages must be kept on hand for spares and for

Figure 12 — Face plates for drum control are hung on the wall.



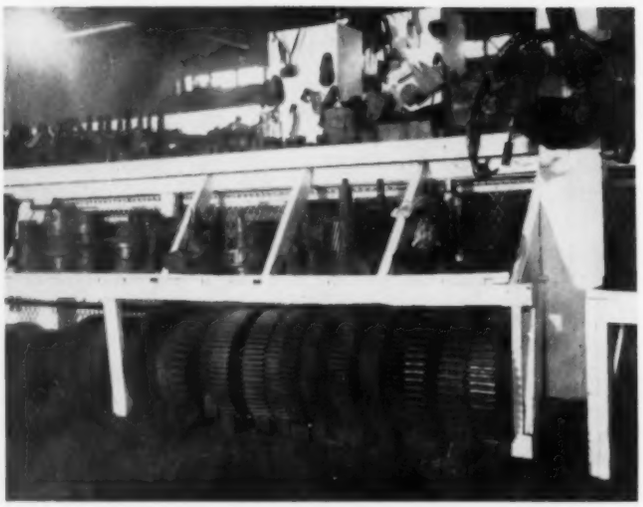


Figure 13 — Heavy objects are stored near the floor.

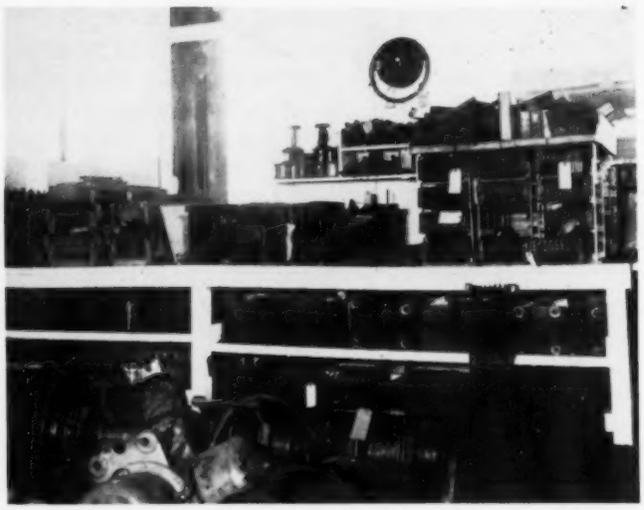


Figure 14 — Resistance banks are stored in racks which are deep enough for just one bank.

emergencies. These are stored in rows on the floor of the storage area which is served by a traveling I-beam crane. A floor type crane could be used but would require more floor space. The overhead type is the safer. Since motors move rather slowly they are packed quite closely to save space. Each motor has a plant serial number plate which allows a card index system to be kept which quickly brings to light the entire plant history of any individual motor as well as all of its characteristics. Motors may be grouped in alternating and direct current classes, and again in sizes and types. Here also a hard, level surface is an advantage, because a vehicle with small diameter wheels may be used, which keeps the load close to the floor during its transportation from place to place.

Pinions of many sizes, pitch, and number of teeth must be kept on hand, especially when these are used in open service, subjected to the abrasive effect of steel mill dirt. These are stored on shelves in a particular location, graded according to size and pitch. Bores are bushed, or bored out as necessity dictates.

Fibre pinions should, if possible, be equipped with a metal quill of such design as to allow the fibrous material to be clamped into position and still be readily removable. They may be changed quickly and their life increased because the material is not distorted as it would be when forced tightly upon a shaft.

Resistance banks are stored on shelves and in racks just deep enough for one bank. See Figure 14. Long narrow frames, such as those used in some types of manual controllers, are stored in pockets made to take the frames endwise, each one without disturbing another. It is a mistake to make shelves too deep. It will invite disorderly storage, interlocking the units so that a single one may not be removed easily.

Resistance grids may be stacked on hangers especially designed to receive them. They can be inventoried at a glance. Each bank has its place, and it is stored there whether it is in good condition or not. If it needs repair, a red tag so indicates; if it is ready to use, it has a white tag indicating its point of use and the fact that it is O.K.

Order and cleanliness make for safety. It is particularly important to have the floor spaces, adjacent to the work benches and in other work areas, free from tools and material. It is also helpful to have electric welding sets, cabinets, tool boxes, certain material racks, and equipment of like character, mounted on wheels or casters of suitable size to carry the weight for occasional moving in order to make more space available for emergencies and in order to make it easy to put them where they belong. It also helps to prevent the accumulation of dirt and refuse around or underneath them. This reduces fire hazard and improves appearance. It also pays off in time saved, when a tool cabinet may easily be rolled to the job where the small tools will be at the workman's hand when a rush repair job is under way.

TEST BOARD

For test runs on motors, and for other shop tests, enough equipment should be provided so that it will not be necessary to run any wiring which will have to be removed after the test. A much quicker method is to have the control permanently mounted and connected, and flexible enough to allow current control at the various required voltages. Heavily insulated flexible cable with suitable snaps, allow connection in a few seconds for the test run, and can be coiled up on a hook out of the way afterward. Protective devices of course, should be provided for safety, and meters provided to indicate currents, especially.

Tools are a problem. There are several classes: they range from the small personal tools which generally are purchased by the workman to extremely large special devices for assembly or dis-assembly of large spare parts, such as those needed for gear and shaft assemblies in the large sizes. They also include special handling devices which experience has shown is necessary to save time in emergencies. Cable slings are somewhat difficult to store, especially where the cable diameter is large, and the sling long. About the best that can be done is to make special hooks on the wall areas. Smaller slings can be hung on ordinary hooks, as seen in Figure 15.

Tools of such size, shape or character that they remain company property should be instantly available

Figure 15 — Slings are kept on a rack.

for use when needed by anyone, to best serve the company's purpose. Sledges, bars, wrenches, jacks, wedges, heavy wrenches, pullers, etc. may be needed at any time. It used to be the avowed purpose of each maintenance crew to so secure tools that they could not be used by anyone in another department and often men would hide tools from their own buddies in the same department. Some of these tools are expensive and it is not feasible to supply everyone with a whole set for occasional use. It is far better to make a tool board, and hang the tools on it in plain view where a missing tool is readily indicated by a vacant space on the board (Figure 16). If the tools are painted a distinctive color, they will in most cases be quickly returned to their rack after use. Enough tools of each kind to take care of peak demand should be provided. Tools, like other things, are hoarded only when they are scarce. For the smaller personal tools, metal boxes on casters provide a good method of storing tools and at the same time make them readily available for use at the shop job. They have a drawer which may be locked, and the top is arranged with a flange all around so that tools may be placed there while working on a job. The box is wheeled to the job and when not in use is parked against the wall out of the way. It is false economy to try to save money by not purchasing or making needed tools. It is well to have enough of the less expensive tools to meet the peak demand for them. This may not be true where expensive hydraulic pullers or heavy jacks are concerned, and one crew may have to wait awhile or find a substitute. In any case, however, such tools should be in plain sight always where they may easily be kept track of.

Old model cranes use copper trolley wires in considerable quantity. They can cause annoying and costly delays. Spare wires are necessary, as well as spare slides and staffs. These are made up complete with insulators, hook bolts, nuts and connectors ready to replace a broken or badly bent wire. Each spare has its place and is tagged for the crane or cranes that may need it. It may be said here that a number of things can be done to keep trolley wires in service, which, if neglected, may cause plenty of trolley wire failure.

First: the use of small wire is a mistake, except for very short spans and small cranes; even then it is debatable. The money saved in first cost of the wire is soon spent in grooved slides, and broken wires. Collector shoes should not be mounted on a round staff which can easily be turned out of line. Slides are generally better than wheels, from the standpoint of long life, provided some method of graphite lubricant is used to prevent metal cutting. Holes may be drilled and graphite rods inserted in the slide surface where the wire bears. Better still, is a graphite material of sufficient strength for the whole slide. With a large wire, a carbon slide and a flat staff to keep the shoes exactly in line, much longer life will result, especially of the wire. The service to which cranes are put has a bearing on the life of trolley wires. Excessive vibration is tough on the whole collector system.

The maintenance department received a break when the motor manufacturers agreed to standardize essential dimensions on general purpose motors. However, spare motors are still quite a problem. They are needed in a wide variety of sizes, types, and speeds. About the best that can be done in the way of storage is on a horizontal plane with some sort of crane sweeping over the storage area, and suitable vehicles and runways provided for rapid and safe transportation.

For the very large clumsy castings and machine parts, storage in the yard is feasible now that effective rust preventive dressings are available. Some of these products are very easily applied and last for a long time without renewal. They are satisfactory for all except the most exact machine work.

Figure 16 — Missing tools are easily spotted on the tool board.

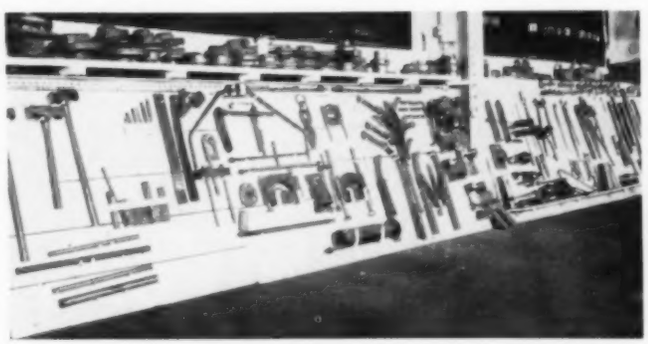
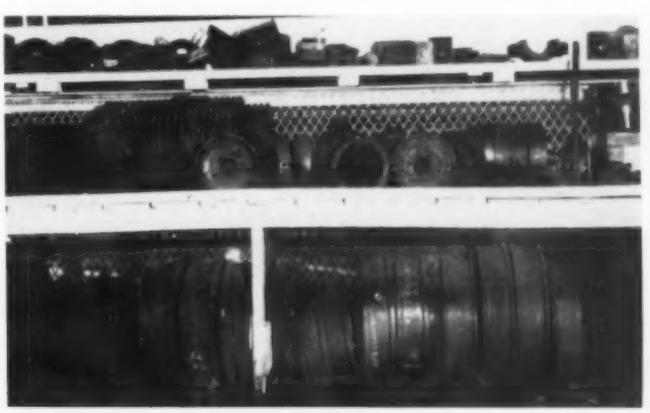


Figure 17 — Wheels and pulleys are stored as shown.



DISCUSSION

PRESENTED BY

E. L. ANDERSON, Superintendent, Electrical Dept., Bethlehem Steel Co., Johnstown, Pa.

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FRANK V. ANTICO, Electrical Engineer, National Tube Co., McKeesport, Pa.

D. W. FERGUSON, Assistant General Foreman, Electrical Department, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

A. W. McAULY, Chief Electrical Engineer, Edgewater Steel Co., Oakmont, Pa.

E. L. Anderson: The illustrations indicate very well the manner in which spare parts can be stored in an orderly manner, and I am sure that the author has presented some novel ideas which will be a benefit to a good many of us.

J. Farrington: We have made round steel cases with cast iron ends for transporting the armatures with their bearings from the mill to the repair shop, making it easy to roll them if necessary without damaging the armature. All armatures of the same horsepower and type have the same standard pinion coupling or brake wheel.

We carry the steel cables for the large tonnage hoist on reels in the correct lengths for easy changing. The cable is oiled and the reels are covered with a sheet band to keep the dirt and weather off, and are stored in the department where they are used.

The small spare parts are carried in bins in the departments, the field and armature coils in a central storeroom. The armature and field coils for the large motors and generators are stored in a special electrical storeroom in wooden boxes, marked and numbered for the equipment for which they are a spare.

We have a man in the electrical storeroom who receives and disburses all equipment. We have over twenty-eight thousand items that we carry in stock, and they are listed in a large loose leaf ledger in the electric office. The foreman in each department carries a record of his equipment and spares on a card system. We have one man who brings the damaged equipment from the mill to the repair shop, making a record where the equipment came from, and returns it to that department when repaired. We store most of our spare motors in an unused building and have a department who keeps a record of these motors and list the excess spare and obsolete motors for use in all plants.

Frank V. Antico: Mr. McAuly has gone to the heart of the handling and storage of spare electrical parts problem when he stressed order, cleanliness and identification. Satisfactory results are impossible without proper application of these principles, and when supplemented with careful planning, they form an unbeatable combination.

We all know that repair shop and storeroom supervisors have a tough spare parts problem. Each year, improvements and new construction necessitate the installation of complex modern electrical equipment, which in turn forces the stocking of a wide variety of relays, solenoids, limit switches, timers, electronic tubes, and so forth. Many of these devices are of special design, and the ordering and maintaining of a correct renewal part stock without complete manufacturer's data is almost impossible. The prompt furnishing of renewal parts sheets and instructive bulletins is a "must" in any planning setup.

These new additions do not displace, but rather add to the existing stock in the storeroom. Inevitably, its space facilities will be taxed to the utmost, and unless the problem is given serious consideration, may lead to inefficient stocking conditions.

This can be avoided if periodic studies are made with the two-fold purpose of eliminating non-moving, obsolete parts from the storeroom bins and coordinating the needs of the various repair shops so as to avoid unnecessary duplication.

D. W. Ferguson: The fundamental requirements for a good program of handling and storing electrical parts has been very well covered. A study of the economics governing such a program will show that a systematical approach, will result in a lower maintenance cost. The initial cost of the part is just a beginning of the actual expenditure. The cost of space, storage, equipment, transportation and records must be added to the original cost.

One of the most common complaints is that not enough space is available for proper storage. Making use of vertical space and designing better racks and bins similar to those discussed will solve many storage problems. The armature storage rack that has been described, is very ingenious, and does away with many of the problems associated with the old style racks.

I think Mr. McAuly is fortunate in having a centralized storeroom. In our plant, each department cares for its own spares, and each has its own storage facilities. This causes some duplication of parts, and in some ways it is not as efficient as a centralized location. This condition is not one of choice, but is caused by geographical location and the great distance from one end of the plant to the other.

Each department keeps a stock of supplies in their own storeroom. Usually a small stock of parts is kept near centers of use, so that they are near at hand when needed.

As Mr. McAuly has said "the normal maintenance man does not show much respect for records and cost accounting." As a result, it is sometimes hard to obtain a man who can take care of the records and who at the same time, is familiar with the parts and their application.

It is indeed well to make every effort to get an able man or men for the job. If the countless records are not handled properly, it can result in records that no one can rely on.

Member: There are two questions in my mind. How do you keep the white paint so white, and how do you store your fractional horsepower motors?

A. W. McAuly: The motors are on the top deck of the rack. The painters come around through the shop periodically, and they were through the electrical department a little while before the photographs were taken. That is why the paint is white. In regard to the storage of motors, we are fortunate, as Mr. Ferguson has remarked, in having space for a centralized storeroom, so that our motors may be stored on a floor, with alleyways between rows, so that the proper vehicle may be used for their transportation. They are handled by means of an I-beam crane.

Properties and Application of Ductile Iron

By G. L. COX
Manager, Empire State Section
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Rochester, N. Y.

. . . . ductile iron is probably the most important new material developed by our foundry industry . . . .

▲ DUCTILE iron is a new engineering material, having unique properties that distinguish it significantly from conventional ferrous foundry products.

Containing small amounts of magnesium, these irons have their graphite in spheroidal form and possess a wide range of mechanical properties and ductility, as expressed by percentage elongation, up to values comparable with steel. Ductile iron has high modulus, close structure for pressure tightness, improved impact resistance over conventional irons, good heat resistance, excellent machinability and high degree of wear resistance.

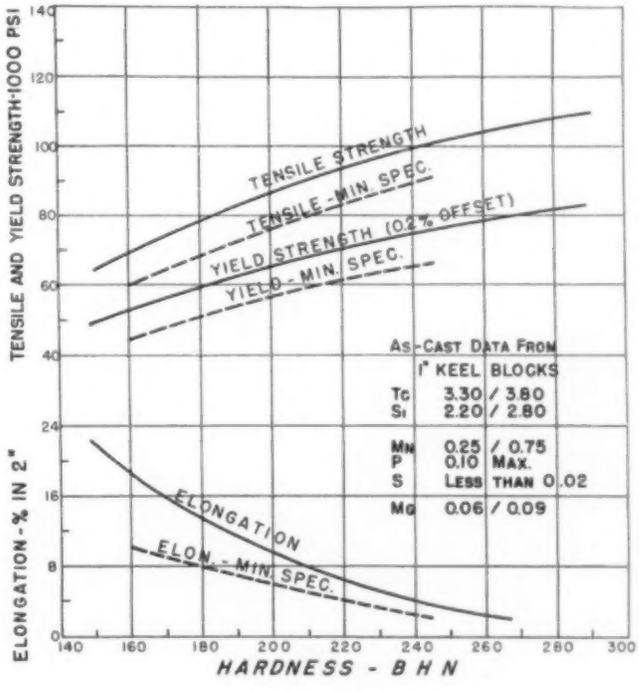
Two years commercial experience with these irons has demonstrated their diversified usefulness in numerous applications where strength and/or ductility are requisites, and such parts are now in manufacture. Of interest to iron and steel engineers are such installations as forging furnace doors, ingot and billet molds, rolling mill housings, roll bearings, wire reelers, bar guides, soaking pit covers, cinder pots, hammer anvils, stamping dies, heavy gears and numerous others.

As its name implies, "Ductile Iron"[1]* is best known primarily because it has, or is capable of taking on, an appreciable amount of ductility, i.e., ability to take deformation. This ability, as in steel, is related to tensile strength and hardness, as contrasted to ordinary gray cast iron, which has negligible ductility at any level of strength. Ductile iron, therefore, constitutes its own specific class of engineering alloys, contributing new and significant properties to the ferrous family.

Starting with substantially conventional cast iron base, either hyper- or hypo-eutectic, the ductile irons possess their unusual characteristics, primarily, because of a metallurgical phenomenon, whereby the graphite, precipitated on cooling of the molten iron, is in the form of spheroids rather than flakes. The presence of appropriate, yet small, amounts of the element magnesium is responsible for this unique change in graphite manifestation. Since discussion of these phenomena and mechanism is covered in previous publications[1], [2], it seems appropriate that this treatise deal only with a resume of the properties and applications to the exclusion of fundamental metallurgical considerations. Those interested in a study of these more basic phenomena are referred to the excellent bibliography prepared by the materials engineering staff of Syracuse University[3] and a few other more recent papers in popular trade magazines.

Ductility, as measured by the conventional tensile test, recording the extent of elongation (% Elong) and/or reduction of area (% RA), in itself, is far from a definitive test, but its usage over the years has permitted designers to apply a given product having these characteristics, and experiences are showing that ductile iron uses can be evaluated on this same basis.

Figure 1 — Chart shows how tensile strength, yield point and elongation is related to hardness of ductile iron.



*Numbers in superscript are references to Bibliography at end of paper.

TENSILE PROPERTIES

The usefulness of ductile iron as an engineering material is, indeed, broadened by the very fact it can be produced in forms where its ductility (as measured by Elong and RA) can be varied over a wide range. Thus, designs that call for toughness at moderate strength (e.g. 65,000 psi) can have it, or if high strength (e.g. 100,000 psi or more) is important, and ductility is not, that, too, can be achieved. Almost any combination between these two extremes is feasible. Ductile iron, therefore, truly bridges the gap between steel and cast iron, and actually goes on a little farther to contribute properties not evident in either.

There now have been nearly two years experience in the commercial production of ductile iron. Fluidity and castability are excellent and comparable with good hyper-eutectic cast iron. Castings have been made that vary from a fraction of an ounce up to 30 tons. Section sizes have covered the range of less than $\frac{3}{32}$ in. up to 36 in.[10], [11] These experiences have provided data that permit development of close control over chemistry and final physical properties, and as a result, it is possible to chart a relationship among tensile, yield, elongation and hardness. Such a chart (see also Gagnebin et al[4]) is shown in Figure 1. These curves represent hundreds of sets of data. While the curves are based upon "as-cast" material, they do apply, as well, to annealed material. Generally, however, the annealed iron will have somewhat higher elongation at the same hardness level.

Ductile iron has a definite and high modulus of 24/26,000,000 psi. This feature is useful in designs where deflection under load must be small and known accurately.

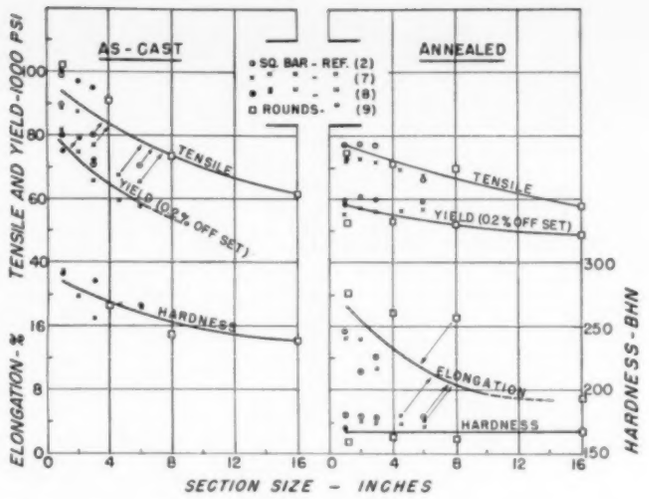


Figure 3 — The increase in section size has an effect on the properties of ductile iron.

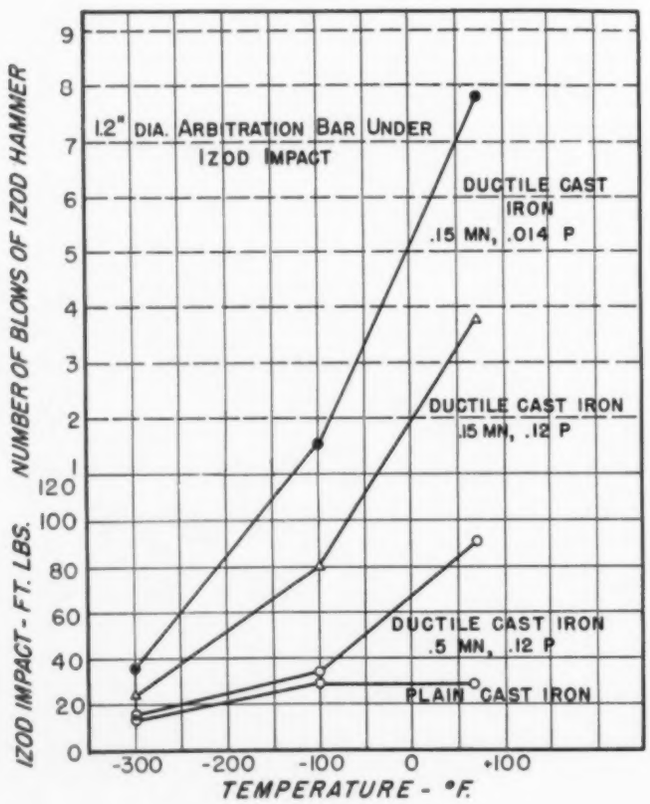

1.2" DIA. ARBITRATION BAR UNDER IZOD IMPACT
DUCTILE CAST IRON .15 MN, .014 P
DUCTILE CAST IRON .15 MN, .12 P
DUCTILE CAST IRON .5 MN, .12 P
PLAIN CAST IRON
IZOD IMPACT - FT. LBS. NUMBER OF BLOWS OF IZOD HAMMER
TEMPERATURE - °F.

Figure 2 — Low temperature impact properties of ductile iron.

CHEMICAL COMPOSITION

The chemical composition ranges of ductile iron are discussed in the basic patents[1] and a typical operating range might be as shown in Table I. Manganese can be varied over a wide range, depending upon the final properties desired. Low manganese is desired for a ferritic and highly ductile iron, or, if a fully pearlitic, high strength, wear-resistant iron is desired, the manganese may be set at the upper end of the range[2]. This iron will not have the highest ductility.

SPECIFICATIONS

The accumulation of commercial experience has permitted the sponsors of this new material to develop tentative working specifications which form a basis for engineering design, purchasing and production control. Table II lists the four grades under which the iron is regularly produced, both minimum and typical properties of a large number of heats in numerous foundries[5]. It is interesting that elongation and reduction of area are similar in values. Most of the iron in the as-cast condition will conform to either 90-65-02 or 80-60-05 grades. The 60-45-15 grade is usually obtained by annealing the previous two grades, but can be, and is being, made "as-cast." In cases where there are no important requirements for ductility, yet a high tensile strength is needed, grade 80-60-00 is indicated. The primary difference between 90-65-02 and 80-60-05 is the base chemistry, and this is usually intentional. A fully pearlitic iron with manganese in the range of 0.50/0.75 will fall in the class of 90-65-02. A partly ferritic iron, with manganese 0.40 or under, will fall into grade 80-60-05. Current practice for this grade is to hold manganese to 0.35 maximum.

The 80-60-00 grade allows not only higher manganese in the heat, but higher phosphorus, as well. While

TABLE I

A Typical Composition Range of Ductile Irons

TC	Si	Mn	P	S	Mg (Preferred min)
3.20/3.90	1.80/2.90	0.15/0.75	0.10 max	less than 0.02	0.05/0.06

TABLE II

Tensile Properties and Tentative Specifications for Ductile Iron

Grade	Tensile strength, psi	Yield strength,* psi	Elongation,* per cent in 2 in.	Reduction of area, per cent	Hardness, BHN	Modulus of elasticity, psi
Typical property range:						
90-65-02	95/105000	70/75000	2-5	2-5	225/265	24/26,000,000
80-60-05	85/95000	65/70000	5-10	5-10	195/225	24/26,000,000
60-45-15	65/75000	50/60000	15-23	14-20	140/180	24/26,000,000
80-60-00	85/95000	65/75000	1-3	1-3	230/290	24/26,000,000
Minimum properties for specifications:						
90-65-02	90,000	65,000	2.0			
80-60-05	80,000	60,000	5.0			
60-45-15	60,000	45,000	15.0			
80-60-00	80,000	60,000	Not indicated			

*Yield strength is taken as 0.2 per cent offset on the stress-strain curve. Elongation is in a 2 in. gage length. Test bars normally 0.505 in. diam from 1 in. keel block.

phosphorus is potently detrimental to ductility and reduces impact resistance[2] (see also Figure 2), it does not interfere with the spheroidization of graphite, and tensile strength is not materially altered. For best ductility, phosphorus should be kept under 0.10 per cent.

Figure 4 — Compressive strength of ductile iron.

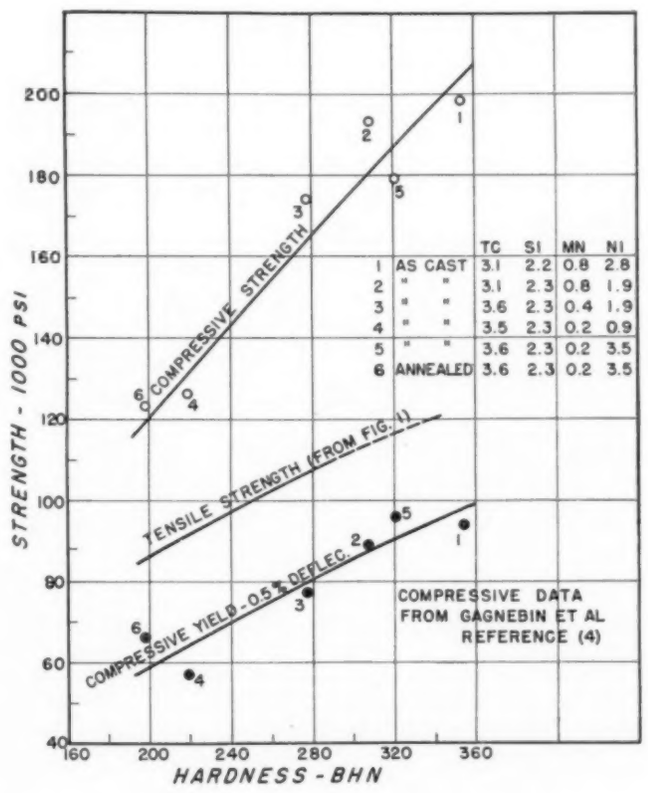
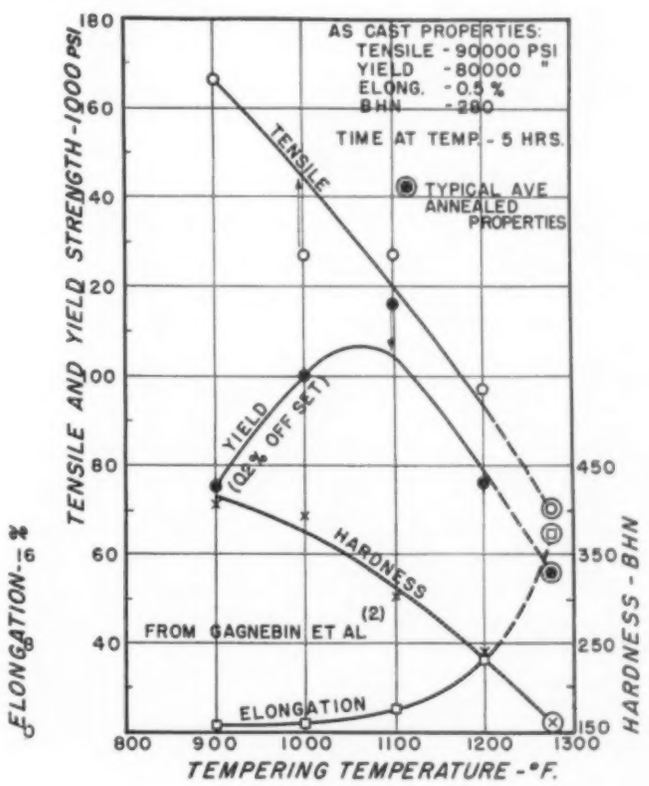

STRENGTH - 1000 PSI
HARDNESS - BHN
COMPRESSIVE STRENGTH
TENSILE STRENGTH (FROM FIG. 1)
COMPRESSIVE YIELD - 0.5 % DEFLEC.
COMPRESSIVE DATA FROM GAGNEBIN ET AL REFERENCE (4)
TC SI MN NI
1 AS CAST 3.1 2.2 0.8 2.8
2 " " 3.1 2.3 0.8 1.9
3 " " 3.6 2.3 0.4 1.9
4 " " 3.5 2.3 0.2 0.9
5 " " 3.6 2.3 0.2 3.5
6 ANNEALED 3.6 2.3 0.2 3.5

Figure 5 — Chart gives effect of normalizing at 1650 F and tempering at various temperatures on the properties of ductile iron.



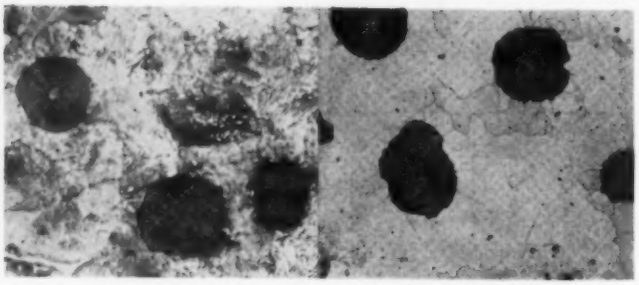


Figure 6 — On left is photomicrograph of ductile iron with pearlitic structure as-cast, and on the right may be seen micrograph of annealed ductile iron with ferritic structure.

CHEMICAL AND PHYSICAL CONTROL

An illustration of the control being achieved in current production of ductile iron is obtained from an examination of a month's record in an electric furnace foundry regularly producing the iron to meet specifications 90-65-02 and 80-60-05. The month's run cited represents over 60 tons of metal treated in 54 ladles and made into castings with section sizes from ⅛ to 2 in. As-cast properties of 0.505 in. tensile specimens from 1 in. keel block test coupons are given in Table III.

ANNEALING

Heat treatment for the annealing of ductile iron is simple. Under ordinary circumstances, the pearlitic (90-65-02) or partly pearlitic (80-60-05) grades are annealed, and thereby increase ductility, by holding at 1650/1700 F for a sufficient time, for any casting, such that all the metal is held for about one hour to accomplish solution of any carbides. Rarely, in the case of strongly carbidic structure, the holding time may be longer, e.g., 4 to 5 hours.[11] This is followed by a ferritizing treatment at 1275/1300 F for about 4-6 hours at temperature. The castings respond and conform to grade 60-45-15.

TEST BARS IMPORTANT

Experience has shown that the conventional arbitration bar used for gray irons is not a good test coupon. The well-fed keel-block, useful in steel castings, is the proper source of test specimens.[2], [6], [7] This same consideration is applicable to alloy high strength gray cast iron, as well as the austenitic irons of the Ni-Resist* family. The size of keel-block may be selected for the particular casting section involved.

EFFECT OF SECTION SIZE ON PROPERTIES

Gagnebin et al,[2] Eagan and James,[7] State and Stott,[8] Allison[9] and Galloway.[10] A report data on specimens cut from several section sizes. Some of these data, combined and plotted, are shown in Figure 3. The general downward trend in the curves confirms that ductile iron follows the well-known pattern for cast steel, whereby tensile, yield and ductility (elongation and reduction of area) decrease as section size increases. Hardness is less affected and it is a common occurrence to observe that 6-in. blocks of ductile iron register uniform hardness across the entire section, both as cast and annealed. Data are insufficient to permit reliable charting of the relationship between as-cast elongation and section size, although it is believed at high as-cast elongation (i.e. up to 15 per cent) the curve would follow closely that for annealed ductile iron. The actual position of the curve would depend upon the initial elongation in the thinner sections. Tensile, yield and hardness seem to fall off considerably less rapidly in the annealed condition than as-cast, there being only about 10,000 psi range in yield from 1 to 18 in. section. However, the fewness of data in the larger sections does not, at this time, permit definite conclusions in this respect.

SURFACE CONDITION

Laufer[11] points out that gating must be designed especially for ductile iron, implying that conventional

*Trade-mark Reg. U.S. Pat. Off.

TABLE III

Range of Properties of 54 Ladles of Ductile Iron Produced in an Electric Furnace

Physical properties—1 in. Keel blocks

	To meet 90-65-02. 32 ladles		To meet 80-60-05. 22 ladles	
	All	31 Ladles	All	20 Ladles
Tensile strength—psi	90,000-94,100	90,000-94,100	81,350-89,800	83,400-89,800
Yield strength (0.2 per cent)—psi	64,650-71,500	68,000-71,500	59,000-72,750	64,000-72,750
Elongation—per cent in 2 in.	3.0-10.9	3.0-10.9	4.6-14.0	6.5-14.0
Hardness—BHN	217-248	217-248	202-241	202-241

Chemical composition range

	All 54 ladles
Total carbon	3.47-3.61
Silicon	2.19-2.53
Manganese	0.41-0.48
Phosphorus	0.093-0.115
Sulphur	0.009-0.018
Magnesium	0.065-0.080

gating for cast iron is not applicable. Surface condition is believed related to gating practice and revisions in types of gating have been successful in producing acceptable castings.

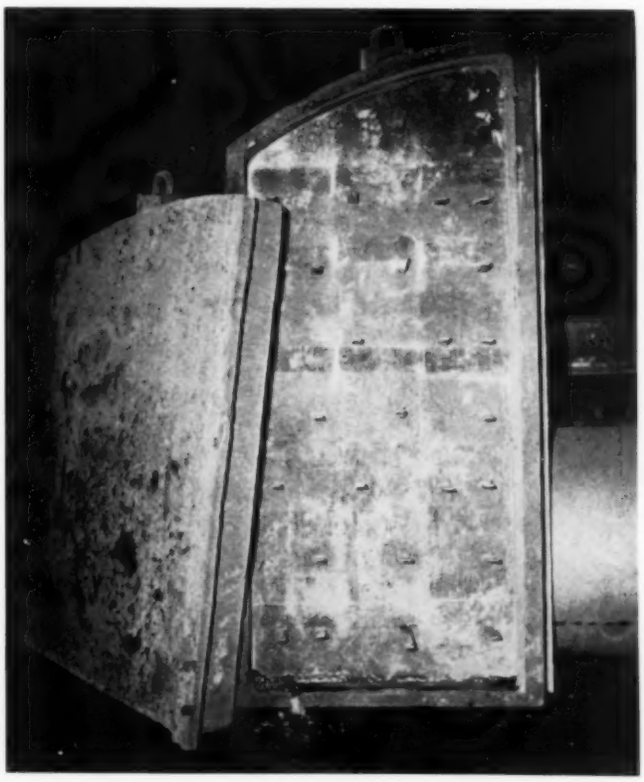
RESISTANCE TO IMPACT

Perhaps second in importance only to its high ductility is the relatively high impact strength of ductile iron: to the steelman—toughness. (The physical metallurgist makes distinction between ductility and toughness. The former is a combined appraisal of elongation and reduction of area values, and the latter is energy required to rupture the material under impact of suddenly applied load.) Ductile iron has been shown to have a high degree of energy absorption, and this feature is one that is under comprehensive research programs. Ductile iron tested under Izod impact on unnotched 1.2 in. diam arbitration bar usually shows energy absorption of the order of 100 to in excess of 120 ft lb (the capacity of the machine). The annealed material will often withstand up to 10 blows from the Izod hammer. A good grade of flake graphite cast iron will absorb only about 20-25 ft lb.

IMPACT AT LOW TEMPERATURES

Using the 1.2-in. arbitration bar to permit comparison with gray irons, some tests were made at the research laboratory of my company to evaluate the effect of low temperature on the impact properties of ductile iron and engineering gray cast irons. Significant data are given in Figure 2. It must be noted that beyond 120 ft lb, the limit of the Izod machine, the energy absorbed can be stated only as a number of blows of the hammer. These have no linear significance with the regular scale, but are indicative of the amount of shock energy this material will absorb. The effect of lowering phosphorus and manganese to eliminate brittle phosphide network, and produce ferrite, respectively, is evident. As a class, ductile iron has significantly higher impact resistance at room temperature than the flake graphite irons. Since they are much higher strength materials than plain cast iron, it would be expected that the impact resistance would fall off more rapidly than plain iron as temperatures are lowered. Nevertheless, they do retain moderate amounts of energy absorption at the lower temperatures. Based upon these data, one could feel reasonably assured of using ductile iron at −100 F, for which there has always been doubt in flake graphite iron.

Figure 7 — These forging furnace doors, which were made of annealed ductile iron lasted 17 weeks compared with 4 weeks for flake graphite iron.



COMPRESSIVE STRENGTH

Compressive strength is important in dies for sheet metal forming, and other applications, such as plungers and heavy bases. Data have been reported on compressive properties[4] and these are charted in Figure 4. The hard and high strength irons are made by appropriately alloying with nickel, along or in combination with the higher manganese levels. These alloys do not possess high ductility because of their high strength producing structure (see Figure 1). Those authors felt the true compressive strength was not attained in the test because the specimens bowed after reaching the yield point. True compressive values would undoubtedly be higher than the data cited. The data, however, are indicative of usefulness under compressive loading. Programs for studying compressive strength are still under way.

DAMPING PROPERTIES

Of importance to users of castings, and in certain applications, especially where vibrations occur, damping characteristics are significant. When struck with a hammer, ductile iron rings like steel. Galloway[9] reports the results of vibrational damping tests which compared ductile iron with steel and gray cast iron. Based upon the time for a vibrating specimen to dampen out, and cast iron taken as 1, ductile iron was 2, and cast steel was 4, supporting the earlier estimate that ductile iron fell somewhere between gray iron and steel. Foundries use the "ring" test as a quick qualitative check on their castings.

MACHINABILITY

Gagnebin[4] has reported the excellent machinability of ductile iron in both the as-cast and annealed conditions. Some more recent data are given in Table IV. These data show that, at the same hardness level, ductile iron machines better than flake graphite iron. In the as-cast condition, machinability ratings would indicate that ductile iron can be machined at higher hardness than ordinary cast iron with no sacrifice in tool life. Because of its toughness, ductile iron generally

TABLE IV

Comparative Machinability of Ductile and Flake Graphite Iron*

Material	Tensile, psi	Hardness, BHN	Elongation, per cent	Cutting speed, fpm	
				For tool life corresponding to 200 cu in. metal removed	For tool life of 60 min
As cast					
Gray cast iron	35,000	195	0	325	320
Gray cast iron	45,000	225	0	310	280
Cast iron-acicular	60,000	263	0	150	160
Ductile iron	85,000	207	17	420	370
Ductile iron	93,000	215	4	310	315
Ductile iron	97,000	265	2	200	210
Annealed					
Gray cast iron	16,000	100	0	960	810
Ductile iron	70,000	170	22	970	680
Ductile iron	77,000	183	20	600	500

Tool life ..... 0.030 in. land wear
Feed ..... 0.010 in. per rev
Depth of cut 0.100
Tool ..... K6 carbide 6 degree true rake
Lubricant ..... None

*Courtesy of Metcut Associates, Cincinnati, Ohio, and Curtiss-Wright Corp., Columbus, Ohio.

requires greater power in machining than does flake graphite iron. It may be machined either dry or with a cutting lubricant. Consistent reports from users indicate general shop machinability is surprisingly good.

GALLING AND WEAR

Cast irons have long been noted for their excellent resistance to galling in metal-to-metal contact. Few materials other than cast iron can be used in dry sliding contact. This kind of service requires both gall resistance (resistance to seizure which causes scoring) and wear resistance (resistance to abraded removal of material). It was gratifying to learn that ductile iron possesses a remarkable degree of resistance to both features. In resistance to galling, it is at least as good as coarse flake graphite iron, and the limited number of wear tests reported shows it is decidedly superior to conventional flake graphite iron. Gagnebin et al[4] report some actual gall test data indicating that scoring and galling loads for ductile iron are significantly higher than flake graphite iron. Research programs are under way to extend knowledge of the wear characteristics of the iron under both wet and dry conditions.

SURFACE HARDENING

As in the case of conventional irons and steels, the wear resistance of ductile iron can be improved by surface hardening. Actual test data are limited, but several comprehensive programs of study are under way and will be the substance of a future paper. A preliminary examination of the propensity of ductile iron to flame hardening was made in the case of some heavy silent chain sprockets, where the regular procedure formerly used for cast iron was employed. A photograph of a section of one of these sprockets is illustrated. The pattern of hardening is optimum and the surface hardness was recorded to be 58-60R_c. These sprockets are outwearing regular flame hardened iron and steel in dynamometer tests where the applied load approaches the yield point of the material. The wearing surface of ductile iron seems to polish smoothly, as contrasted to "pitting" in the case of flake graphite iron. (This pitting is believed to be due to the removal of flakes of graphite and sizeable particles of the base iron.) Table V lists results of some flame hardening on 1 × 1 × 8 in. test blocks. While the annealed samples showed slightly less hardening propensity, evidently due to the absence of pearlite in the structure and lower combined carbon in the matrix, thus lower hardenability, both conditions resulted in satisfactorily hardened metal. The hardness of 610 BHN in the as cast, flame hardened condition compares favorably with the reported hardness of 58-60R_c (614-653 BHN by conversion) for the sprockets described above. Induction hardening is equally appli-

Figure 8 — The hydraulic head for this billet conditioner was made from ductile iron with a tensile strength of 92,000 psi, yield strength of 67,000 psi, and elongation of 7.8 per cent.

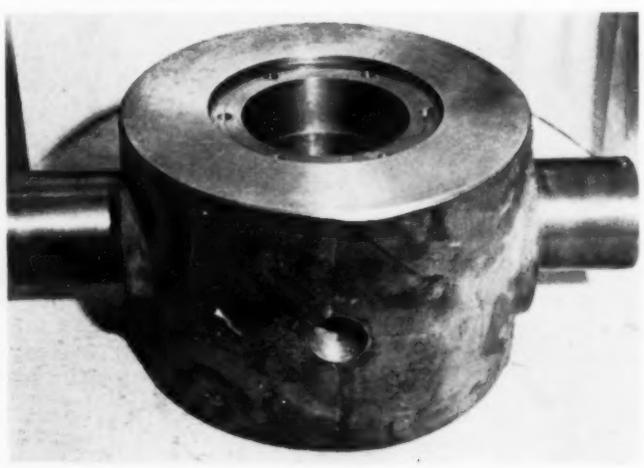


TABLE V

Flame Hardening of Ductile Iron

Tip	¾ in. flame hardening
Quench	0.3 gal/min, 60 F
Tip to work and torch speed	½ in. at 5.5 in./min
	⅝ in. at 5.0 in./min
Gas pressure—Acetylene	11.5 psig at 74 cfhr
Oxygen	12.0 psig at 80 cfhr
Specimens	1 x 1 x 8 in. from 1 in. keel blocks

Type of iron	Condition	Hardness—BHN*	
		Before hardening	After hardening
Ductile—0.16 Mn	As cast	160	610
1.60 Ni	Annealed	150	555
Ductile—0.34 Mn	As cast	180	610
1.00 Ni	Annealed	176	535

*BHN converted from Rockwell A.
Full transformation depth—0.06 in.
Heat affected zone depth—0.20 in.
Estimated temperature of surface—1500-1650 F.

TABLE VI

Endurance Properties of Ductile Iron*

Condition	Tensile, psi	Hardness, BHN	Endurance limit—psi	
			Unnotched	0.05 in. Notch
As cast	93,000	236	41,000	.....
Annealed	75,000	181	37,000	.....
Annealed	63,000	148	29,000	.....
Annealed	72,000	170	24,000	18,500

*From Gagnebin et al[2] and Eagan and James.[7]

cable to ductile iron. A preliminary test on a 3-in. block developed a hardness of 578 BHN.

PRESSURE TIGHTNESS

The network of flake graphite, forming relatively continous paths of weakness through the section of gray cast iron, is responsible for the often lack of pressure tightness. Ductile iron avoids this feature because all the graphite is contained in the non-connecting spheroids. As a result, ductile iron offers pressure tightness to an extent not heretofore available in the flake graphite irons. A 9-in. bore hydraulic cylinder operating at 500 tons pressure is illustrated, and thousands of hydraulic jack cylinders, formerly made of steel, have been produced to withstand 8000 psi pressure.

ENDURANCE

Fatigue, or endurance, is a property the designer must take into consideration for applications where repetitive cyclic stresses are involved. It is necessary to know the so-called "fatigue limit," the stress at which the metal will withstand repeated application of stress indefinitely. Endurance properties have been reported by Gagnebin et al[2] and Eagan and James[7]. As with other materials, endurance varies with tensile strength and condition of the specimen, i.e., whether notched or unnotched. Typical data are given in Table VI. It may be seen that the ratios of endurance limit to tensile strength are 0.44 in the case of as-cast material, and 0.34-0.50 for the annealed, unnotched specimens. Notched specimens of

Figure 9 — Heavy duty silent change sprocket made of ductile iron is shown after dynamometer test. Section shows flame hardening pattern. The surface hardnesses of the teeth were 58-60 R_C. As cast the properties were tensile strength, 94,800 psi; elongation 4 per cent, and BHN, 195.

Figure 10 — Weighing over 30 tons, this ductile iron steam hammer showed properties of 44,600 psi tensile; 43,000 psi yield strength; 2 per cent elongation; and a BHN of 161.

annealed material have a ratio of 0.26. These values are of reasonable magnitude. A good grade of flake graphite cast iron will show an endurance-strength ratio of 0.30-0.40 unnotched, and 0.20-0.30 notched. Cast and wrought steels are accepted to have a ratio of about 0.40-0.55, unnotched, and about 0.20-0.40, notched, in the common tensile ranges.

HEAT TREATMENT

An outstanding feature of ductile iron is its resistance to oxidation and growth. Gagnebin[9] reports the results of some tests that show ductile iron to be 17 times more resistant to oxide penetration at 1600 F than gray iron, under the same conditions, and nearly three times more resistant than a Cr Ni heat-resistant iron. Likewise, after 100 cycles heating to 1600 F and cooling, ductile iron exhibited growth 40 per cent less than a Cr Ni heat-resistant iron and only one-sixth that of a conventional gray cast iron. The usefulness of ductile iron in heat-resistant service has been substantiated in numerous commercial applications, an important one of which is doors for forging furnaces. In one large shop, ductile iron lasted 17 weeks, as against 4 weeks for gray cast iron[12]. A large non-ferrous alloy mill has used ductile iron for copper billet molds. Numerous preliminary reports indicate ductile iron offers considerable advantage over regular flake graphite irons for glass molds. Steel ingot molds are in service with incomplete results.

WELDABILITY

Primarily because of its high ductility, ductile iron is often used in structures where welding is desirable, to either other materials, such as steel, stainless steel, etc., or to itself. A nickel base welding electrode has been found successful for this purpose. This same electrode is used for the repair welding of castings.

CORROSION RESISTANCE

A thorough evaluation of the corrosion resistance of ductile iron will obviously await the accumulation of actual service records to compare with laboratory data. The material is being included in the hundreds of field corrosion tests regularly conducted by my company's corrosion engineering section, and future corrosion dissertations will include ductile iron. Some significant data on five simple corrosives are given in Table VII. These, and other preliminary results, indicate that ductile iron possesses, in an overall sense, corrosion resistance comparable with good gray cast iron. In instances where the corrosion process removes the iron matrix and leaves behind the lacy network of flake graphite in ordinary cast iron, this film may protect or it may accelerate corrosion of the underlying iron. The tiny spheroids of graphite in ductile iron do not interlace to permit the formation of this kind of graphite film; hence, it could be postulated that in those instances where a graphite film would be protective, ductile iron may not experience graphite film protection. On the other hand, in those frequent cases where the graphite film accelerates corrosion by galvanic action between the graphite film and the underlying base metal (often referred to as "graphitic corrosion"), ductile iron will be superior to flake graphite iron.

TABLE VII

Some Corrosion Data on Ductile Iron

Corrosive	Duration, days	Temp, F	Corrosion rates—Inch/year			
			Ductile iron		Gray cast iron	
			As cast	Annealed	As cast	Annealed
Tap water—aerated	28	86	0.025	0.020	0.035	0.028
Sea water—rapid motion	4	60	0.058	.....	0.060	.....
3.5 per cent NaCl—aerated	28	86	0.025	0.016	0.027	0.021
5 per cent H_2SO_4—aerated	1	86	8.7*	4.1*	6.5	8.2
50 per cent NaCH	10	70	0.018	0.018	0.017	0.022
	9	260				

*Average of two tests.

Note: The ductile iron conformed to the general chemical range given in Table I. The cast iron was a typical low phosphorus gray iron with TC 3.25, Si 2.92, Mn 0.60, P 0.08, S 0.17.

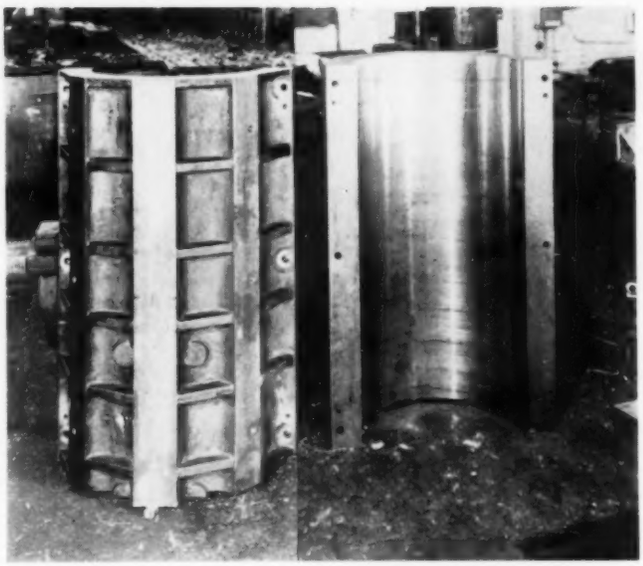


Figure 11 — The ductile iron dies shown are used to form 24 to 36 in. pipe from ¼ to ½ in. steel plate. They are used in hydraulic presses under 18,000 tons pressure. Both sides of the dies are shown in the illustration.

NI-RESIST CAN BE MADE DUCTILE

Pertinent to corrosion considerations is the fact that ni-resist, a well-known family of austenitic cast irons, can be produced with spheroidal graphite and thereby made ductile. Magnesium contents of the order described for ductile iron[1] produce in this material tensile strengths of 65,000 psi, with elongation of the order of 15 per cent, comparing with 30,000 psi tensile and 0.5 per cent elongation in the regular flake graphite ni-resist castings. This is important to corrosion engineers, because it makes available to them a material possessing the corrosion resistance of ni-resist with the mechanical properties of steel castings.

STEEL MILL USES

It is evident from progress so far that ductile iron will find wide application in steel mill and steel fabrication uses. Existing uses comprise hammer anvils, heavy forming dies, forging furnace doors, ingot and billet molds; also, heavy gears and gear boxes, rolling mill housings and drive couplings, table rolls, apron plates, roll bearings, which outwear cast iron 4 to 1, slag pots weighing 25,000 pounds, wire and bar guides and grips, wire blocks (reelers), sintering machine grates, soaking pit covers, open hearth roof hangers, nail bluing tubes (heat-resistance), light forming dies, mostly as-cast but some oil quenched and drawn to R_c58-60, C-clamps for general and special purposes, and others. Many of these applications are outperforming previous materials, some are new and performance data are not yet available.

SUMMARY

Though commercially only about two years old, ductile iron has made a tremendous impact upon the metal industry. Its properties, compared with conventional materials, are unique. Knowledge of these properties is still incomplete, and will be so for some time. However, one can hardly pick up a popular trade magazine that does not contain some additional contribution to the understanding of this material. Knowledge is use; hence, as experiences gather, these, combined with the constant research and development of numerous agencies and production foundries, will gradually round out the picture of a product considered by many to represent the most significant progress in the history of our great foundry industry.

BIBLIOGRAPHY

1. U. S. Patents 2,485,760; 2,485,761; 2,516,524.
2. "*Ductile Cast Iron — A New Engineering Material*," by A. P. Gagnebin, K. D. Millis and N. B. Pilling, The Iron Age, Feb. 17, 1949.
3. "*Nodular Iron — A Bibliography*," by F. R. Morral, American Foundryman, July, 1950, pp 61-64.
4. "*Engineering Applications of Ductile Cast Iron*," by A. P. Gagnebin, K. D. Millis and N. B. Pilling, Machine Design, January, 1950.
5. "*Inco Writes Specs for Ductile Iron*," by A. P. Gagnebin, The Iron Age, May 4, 1950, pp 89-90.
6. "*Improved Test Bars for Standard and Ductile Grades of Cast Iron*," by R. A. Flinn and R. W. Kroft, American Foundry Society, Preprint No. 50-1, 1950.
7. "*A Practical Evaluation of Ductile Cast Iron*," by T. E. Eagan and J. D. James, The Iron Age, December 8, 1949, pp 75-79; December 15, 1949, pp 77-82.
8. "*Some Experiences in Producing Ductile Iron*," by E. M. State and R. L. Stott, The Foundry, July, 1950.
9. "*Spheroidal Iron — A New Engineering Material*," by F. H. Allison, Jr., United Effort, United Engineering and Foundry Co., January-February, 1950.
10. "*Ductile Iron for Heavy Machinery*," by C. D. Galloway, III, The Iron Age, August 3, 1950, pp 75-78.
11. "*Ductile Iron in Light Sections*," by E. J. Lauffer, The Iron Age, August 10, 1950, pp 79-82.
12. C. A. Karns, Steel, July 17, 1950.

DISCUSSION

PRESENTED BY

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R. K. GLASS, Assistant Chief Metallurgist, Republic Steel Corp., Buffalo, N. Y.

W. C. DANIELS, Assistant Mechanical Supt., Bethlehem Steel Co., Lackawanna, N. Y.

R. R. KOTTMEIER, Technical Representative, Canadian Liquid Aire Co., Hamilton, Ontario, Canada.

Member: Mr. Cox, could you tell us where the dividing line is between gray iron and ductile iron?

G. L. Cox: Gray cast iron has a tensile strength seldom exceeding 70,000 psi and no ductility as expressed by elongation. The general run of cast irons will range from 30,000 to 35,000 tensile, and no ductility. Ductile iron has tensiles from 65,000 to 125,000 psi, with elongation values up to about 20 per cent. By quenching, or normalizing, and tempering, the tensile strength of ductile iron approaches 200,000 psi. Therefore, ductile iron truly bridges the gap between cast iron and steel.

T. G. Bradbury: What success have you had with ductile iron in the application of slag pots and ingot molds?

G. L. Cox: Data is not too definite, some is good and some is bad. Castings that performed poorly were examined and found to be defective and high in alloy content. We believe a sound casting, low in alloy and with proper magnesium content, stress relieved or annealed before service, will make a good ingot mold.

R. K. Glass: The best blast furnace iron available for ingot molds is a low phosphorus bessemer grade iron, as it withstands thermal shocks better than higher phosphorus irons. High combined carbon should be held to a minimum in molds as it breaks down at high temperatures and graphitizes, causing surface growth which contributes to "alligatoring," or cracking of the inside surfaces, causing mold stickers.

T. G. Bradbury: In view of a considerably higher strength claimed in ductile iron, is it reasonable that slag pots could be reduced in section thickness and thereby lessen the effects of thermal shock during tapping?

R. K. Glass: Tests to date are too limited to appraise ductile iron for slag pots. While tests have been made on ductile iron varying from 1 to 3-in. sections, actual information is very indefinite, and considerably more work will have to be done to obtain results where the castings are subject to thermal shock. However, on certain type castings where the physical properties are greater, you can usually decrease the section size to correspond.

T. G. Bradbury: Can chilled ductile iron be used for rolls?

G. L. Cox: Magnesium-containing cast iron can be chilled. A Pittsburgh company is a licensee to make ductile iron, and while I do not have the specific details, I understand they intend to make rolls from it. Ductile iron has a high modulus (25,000,000 psi) and that property should be a useful attribute.

Member: Has there been any ingot molds made of ductile iron?

R. K. Glass: I understand the Crucible Steel Co. at Syracuse, N. Y., had some made as experimental to compare with gray cast iron. Some failures were attributed to casting strains; however, I believe the major trouble is due to a low resistance to thermal shock at the high temperatures involved.

Member: Were the molds annealed before using?

G. L. Cox: The molds were not annealed.

W. C. Daniels: When do you add the ingredients in the manufacture of ductile iron?

R. K. Glass: The making of ductile iron is a ladle process.

T. G. Bradbury: Will it chill white?

G. L. Cox: Yes.

T. G. Bradbury: In view of the effect of magnesium on graphitic carbon how can ni-hard be improved by the addition of magnesium as you stated, when ni-hard does not contain graphite in the first place?

G. L. Cox: I refer those interested in the details to U. S. Patent 2,516,524. Ni-hard made by the magnesium process does not contain chromium and thus the carbide manifestation is different. Extensive tests show ni-hard made by the addition of magnesium is tougher in the conventional deflection test.

R. K. Glass: Please explain the properties of malleable iron versus ductile iron.

G. L. Cox: Ductile iron is generally stronger and tougher than ferritic malleable. Malleable (ferritic) has a tensile strength of about 50,000 psi, yield of 35,000 and elongation about 15 per cent, as contrasted to ductile with tensile from 65,000 to 125,000 psi, with elongation in the annealed condition often exceeding 20 per cent. Ductile iron is tougher than malleable, due, primarily, to the more favorable conditions presented by spheroids of graphite as contrasted to the irregular shaped nodules of temper graphite found in malleable. Pearlitic malleable approaches the average strength of ductile iron, but has less annealed elongation and is not as tough. Ductile iron is relatively fool-proof in the foundry, allows a wider range of chemistry, and its base composition more nearly approaches that of gray iron. In other words, ductile iron is made with gray iron practice.

R. R. Kottmeier: What do you use in welding of ductile iron?

G. L. Cox: We use a 55 per cent nickel 45 per cent iron core coated electrode developed for welding high phosphorus cast iron. Research and use have shown it to be the proper material for welding ductile iron, and superior to anything yet tried. Techniques are simple, and excellent, machinable welds result. Ductile iron is being welded with this, both in fabrication to itself and to other materials, and in repair.

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ASSOCIATION OF IRON AND STEEL ENGINEERS, 1010 EMPIRE BUILDING, PITTSBURGH 22, PA.

MAINTENANCE OF BUILDING STRUCTURES

By R. O. CHAPMAN
Field Foreman, Mechanical Dept.
Bethlehem Steel Co.
Sparrows Point, Md.

. . . . maintenance of buildings is a continual problem which requires constant work and proper care.

▲ THE maintenance of buildings is a problem all industries have whether they want it or not, and we all know that the structures that house the productive machinery must be kept in good condition and appearance to maintain top production. Also as production increases, so does the wear and tear to the structures.

In order to maintain a building or buildings in good condition, a yearly maintenance program should be set up. This program should first find out the condition of the structures and what maintenance and repairs are needed; second, decide what is to be done; third, schedule when these repairs are to be made; and fourth, follow the program through to completion. Where a plant is of sufficient size, a separate force should be set up to develop this building maintenance program and to see that it is carried through. Starting near the end of the previous year's program, this force should make a survey of *all* structures throughout the *entire* plant. Working in groups or in pairs, they should carefully look over every building structure and note and classify defects in report form. The previous year's reports should be checked as the survey progresses to see whether any defects previously noted have been overlooked or have been repaired. In this survey, unsafe conditions, poor housekeeping, structural defects of buildings and crane runways, poor design, mechanical wear, and paint conditions should be noted, as well as the condition of the roofs, sidings, window frames and glass, and cleanliness of the buildings and structures.

The defects noted should be reported in a survey report for each area or each mill and classified as to their importance as Class "A," Class "B," and Class "C." Class "A" refers to work that requires immediate repairs. Class "B" and "C" call for a lesser degree of urgency, but should be repaired when time permits. Structural defects noted should be "keel" marked where possible. Also they should be noted in the report by location reference to engineering drawings, building column numbers, etc. After the reports are compiled and approved, copies should be sent to all concerned. (Figure 1 shows a page of the Survey Report.) After carefully going over the reports, repairs to be made the following year should be determined and detailed estimates made, showing the nature of repairs, the cost, the hours, the crafts involved and the materials needed. The estimates should then be sent to the department superintendents with the recommendation that they issue a written order to the maintenance department authorizing them to proceed with the repairs recommended. (Figure 2 shows estimate sheet.)

Figure 1 — Repairs on survey report are broken down into Class "A," "B" and "C."

PLATE MILL SLAB YARD CRANE RUNWAY GIRDER

(SOUTH CRANE RUNWAY GIRDER)

CLASS "A"

Crack in the connecting clip at shear bearing connection - column No. 3.

Crack in the web and under the top flange of crane runway girder. Loose rivets and cracked plate in back of column connected to the auxiliary girders - column No. 6.

The following defects were noted at column No. 9 - loose rivets and cracked plate in back of column connected to the auxiliary girders; connecting angles, both in the face of crane runway girder and in back are cracked; rivets are sheared in the bottom flange connected to top of column; loose rivets in the top cover plate, connected to top flange of crane girder; flange of the column above the level of the crane runway girder is distorted.

Connecting angles in the end to end crane runway girder connection and the diaphragm connection in back of crane girder are cracked at columns Nos. 9 and 13.

The full length of the crane runway cover plate under the rail flange is showing much wear. In some places, the plate is worn in two and also showing cracks throughout.

CLASS "B"

Loose rivets in the end to end crane runway girder connections and the stiffener plate connected to the back of column and auxiliary girders at columns Nos. 4 and 5.

CLASS "C"

Column No. 20 above the crane runway level is distorted.

The yearly schedules should then be set up listing the jobs, crafts involved, the hours allowed, the cost and approximate time of the year that these jobs should start, with space allowed to record the time and cost as the jobs progress. (Figure 3 shows Schedule Form.) This will permit comparison at all times between estimates and true cost, and any discrepancy can be quickly noted. It also gives a monthly check as to whether the building repair program is on schedule. This schedule of repairs, as well as the detailed estimates, copies of the survey, orders, etc. can then be turned over to the maintenance departments involved for execution. The maintenance departments have to have the necessary supervision, labor, tools, and equipment to make general repairs to all types of buildings and structures. After the maintenance departments have studied the program, and find they are unable to handle a particular job or jobs due to the special nature of the work involved, or because they may be of such magnitude that they do not have force enough available to do them and still carry on their regular maintenance program; then these jobs should be placed out on contract to outside concerns on a competitive bid basis. The building maintenance force which made the original survey may be used to help supervise, and coordinate the work of the various plant maintenance forces on the various building repair jobs. They can also act as company representatives to the outside contractor forces, so as to insure proper performance of such jobs.

The only way to get a large building repair program completed is by careful job planning. A great many repairs have to be made under operating conditions or when the mill is down for other repairs or when weather conditions permit, thus allowing only a small amount of time in a year to complete a particular job. As stated before, the only way it can be done without causing unnecessary delays in production is detailed job planning and close cooperation with the operating departments.

I would like to mention a few defects you may find in buildings and structures with some suggestions as to what can be done about them, and also to make a few comments on building materials.

Figure 2 — Illustration shows a typical estimate sheet.

LOCATION - PLATE MILLS

Estimate # 103

JOB - Structural Repairs to 160" & 110" Mills Furnace Buildings.

Charge R-5-A

DESCRIPTION	DRAWING NUMBERS	HOURS	QUANTITY	UNIT COST	AMOUNT
Repair bottom chord of lean-to roof trusses at correcting points over furnaces by replacing sheared angles and rivets, and erect a plate bracket from colum to truss at columns #5 and #6 West side and #6 and #7 east side in 160" mill. In the 110" mill the points are at columns #3, #4 and #9 west side and columns #2, #3, #4, #6 and #10 East side.					
Reinforce 24 excessive large holes burnt in the web of the crane girders to allow door cables to pass through.					
Erector		396		$x.xx	$x,xxx.xx
Welders		66		x.xx	xxx.xx
Riggers		132		x.xx	xxx.xx
Materials					xxx.xx
			Total		$x,xxx.xx

Prepared by - R. O. Chapman

Date Prepared 12-13-50

Crane runways—Defects to look for include:

1. Cracks in rolled steel crane girder sections.
2. Worn cover plates.
3. Loose and missing rivets.
4. Loose and cracked diaphragms.
5. Cracked top flange angles on built-up girders.
6. Worn runways, rails and joints.
7. Missing rail clamps.
8. Holes burned in the girder web or flange with a burning torch.

Burned holes in the bottom flange of a rolled girder section have caused more complete failures than any other reason. It seems to have been a thoughtless practice in the past to burn holes in structural members; for hanging pipe lines, attaching slings for lifting, or for making connections, etc. If you are thinking of increasing the loads on your runways and have burned holes in them, I would strongly suggest reinforcing these sections or you may run into trouble. Or even if your loads are not to be increased, existing burned holes should be welded up or reinforced as they will probably cause trouble sooner or later.

The cracks in the rolled girder sections are generally found to start at the ends in the web under the top flange, or at the top rivets of the end-to-end girder connection. If these cracks are not repaired, they will gradually become longer, working downward to the bottom flange, and complete failure will eventually result. They can be satisfactorily repaired by welding the crack and then welding vertical stiffener plates near the end.

Of course, it is good practice to keep all rivets tight. In some cases where rivets have been replaced with bolts, it has been found that when lock washers were used, these have cracked, allowing the nuts to work loose. It is better to tackweld the nut.

Also it is not good practice to allow the top cover plates of built-up crane girders to become worn too thin by the sliding action of the rail, as this will cause the top flange angles to crack, thus making it necessary to replace them when repairs are made.

PAINTING AND PROTECTIVE COATING

Most of the metal that is lost on building steel is lost by rusting, either by the elements or chemical attack. This is due to the lack of protective coatings, the use of wrong types of coatings or hidden pockets that you are unable to coat. There must be a thousand kinds of paint —some good and some bad. There is no one paint good for all conditions. You must take into consideration the cost, weathering conditions, the appearance desired, etc. Some coatings when applied to general mill buildings may last 15 years, but if the same coatings were applied in a highly corrosive atmosphere, they might not last two months. Paint coatings must be selected for different locations and different conditions. In places that are contaminated by acid-laden vapors, the run-of-the-mill paints will not stand up. In general, a heavy asphalt-type coating will offer a much better protection under acid fume conditions. One way of finding out how to select the proper protective coatings, after investigating all that the manufacturer claims about them, is to keep a record of the paints used on all paint

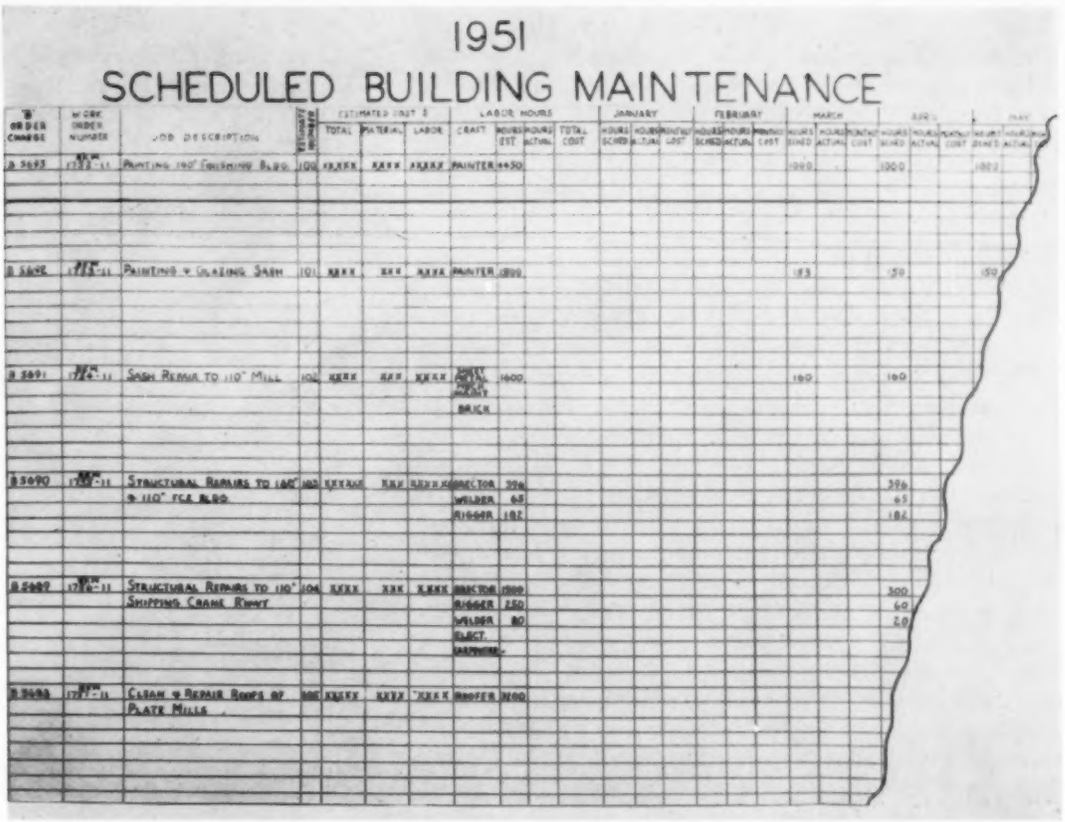

Figure 3—Jobs are scheduled as indicated on this scheduled building maintenance form.

jobs, inspect these jobs periodically, and then decide for oneself after a period of years. Speaking of acid or fume conditions, it is generally better and cheaper to control these vapors by proper ventilation or exhaust systems wherever possible than try to find a paint that will stand up in those conditions. In buildings where acid fumes exist, steel sash deteriorates quickly and has to be replaced quite often. Glass brick may be successfully used in many of these locations. Many mill buildings are enclosed with corrugated protected metal for side walls and roofs. This material offers a fairly satisfactory protection as long as the protective coating is not damaged. This coating can be damaged easily by improper handling in storage and erection and by other repair workers moving materials and equipment over the roofs. When the coating is ruptured, exposing the steel, rust sets in quickly, and will often eat away for metal back under the good coating. In order to prevent this, the sheets, after they are completely installed and all roof traffic has ceased, should be sprayed with a coat of asphalt to make sure that no metal is exposed. One very important thing to remember about these materials is, that under certain conditions they are highly inflammable and should be treated as such. Most manufacturers now make an asphalt "asbestos-impregnated" corrugated material that offers better fire protection than the original type of protected metal.

Another item worth mentioning is that it has been found very bad practice to partly encase structural members that are exposed to the weather, such as column bases, in concrete or brick. Generally the steel is not properly cleaned, the concrete or brick does not bond to the steel and the steel rusts out behind the covering. It is felt that in most cases all structural members should be exposed at all times so that they may be examined and maintained properly.

ROOF REPAIRS

About every five or six years, the weather coating on protected metal roofs will need additional protection. A cold asphalt application, either brushed or sprayed, will protect these roofs for another five or six years if applied in time. On high and low bay buildings, the newer building roof decks are generally "aerocrete" while the older buildings are "gypsum" covered with a built-up waterproofing. In general it is felt that an "aerocrete" roof requires less maintenance than a "gypsum" roof. The replacements on "gypsum" roofs are generally caused by leaks through the waterproofing which rust out the reinforcing wires, thus weakening the slab. However, if the waterproofing is kept in good condition, "gypsum" roof should be satisfactory where not exposed to fumes. The corrugated "cement-asbestos" type of roof or siding is also quite popular in some plants. However, this material, when applied on steep roofs where it is necessary to walk when making other repairs to the buildings, may be found to be slippery. It is also fairly brittle, and if used at low levels on sides of buildings that can be hit by machinery or material, it may crack up under impact.

BRICK BUILDING

Everyone has probably experienced leaks in brick side walls of both old and new buildings. Most of the colorless waterproofings are generally unsatisfactory over a long period of time. The best way to stop this leakage and maintain the brick appearance is to cut out the joints and repoint with a good water-proof mortar. Also insisting on the masons installing full joints using the proper mortar mixture when laying up

a wall, may save a lot of headaches later. There is also the trouble of leakage around steel sash and frames. This can generally be corrected by imbedding the sash and frame in a good caulking compound.

SASH AND SKYLIGHTS

You may find leaks in the monitor "puttyless" type of sash. This can generally be corrected by lengthening the top and bottom flashing. However, in some cases you may have to resort to caulking in order to keep them from leaking. Many of the newer types of buildings have corrugated glass skylights. If they are properly installed and properly caulked at the time of installation, they should give very little maintenance trouble. They also afford good lighting.

In conclusion, I would again wish to point out that the maintenance of buildings and structures is a continual problem. Constant work is required to keep them in safe condition and to have them present an appearance of which the whole plant can be proud. Too often buildings and structures are not given the proper care by the workmen. They are often abused, as broken windows, crudely drawn pictures on walls, twisted doors, burned holes in crane runways, etc. will show. Industries spend a great deal of time and money on training men in the use of equipment and tools and in performing production jobs, but I wonder if enough time is spent on teaching men the proper respect for building structures.

DISCUSSION

PRESENTED BY

J. S. MORRIS, Superintendent Maintenance Control, Lukens Steel Co., Coatesville, Pa.

WILLIAM C. SCHULZ, Superintendent Power and Maintenance, Bethlehem Steel Co., Steelton, Pa.

R. O. CHAPMAN, Field Foreman, Mechanical Department, Bethlehem Steel Co., Sparrows Point, Md.

J. S. Morris: If you have a periodic building inspection, by whom is it done? Do they depend on the riggers or do they have a special inspection department set-up for it? How often does the author recommend the painting of the regular steel mill buildings, and does he recommend patch-painting rather than painting the entire building?

William Schulz: Have you used plexiglass instead of corrugated glass in any of your buildings?

R. O. Chapman: Mr. Schulz asked a question about replacing corrugated glass lights with plexiglass. It has just been recently—in the last six months or so—that we have installed corrugated glass down at our plant, and the only place we do use plexiglass is on doors in most mill buildings and service buildings where we have a lot of breakage. We do use it there, but we have not considered it too much as to replacing corrugated skylights.

Mr. Morris asked about the inspection of our buildings. We make a thorough inspection once a year. That is, we go over every building and every structure very carefully. Of course we have a more or less special force of cleaners—they do not spend all their time inspecting, but are given a certain area to look after to see that these buildings are repaired and maintained, and repair programs are carried through. If outside contractors come in they see that we get what is called for in the plans or specifications. One of the qualifications is not that they be riggers, but they have to climb, and are expected to go anywhere that a rigger will go.

As to patch-painting, I have had some trouble about that on the painting force. They tend to say, "Well, we have our scaffold up; it is as easy to paint the whole building—there is the expense of the scaffold, and that sort of thing"—but I just cannot go along. If it is a matter of spots that are rusted and show corrosion, rather than spend a lot of money applying red lead to the whole structure, which is of course a rust inhibitor, I prefer to save that red lead and just spot paint where necessary with red lead and put the finish coat on over the entire structure.

As to how often to paint a building, I really could not answer that. It depends on the location, down in the coke plants where there are fumes and condensation, and quenching units, which are very highly corrosive, even the best of paint will go bad very quickly. Where we have been using carbon black or cheaper material, we have found out that actually we were only wasting our time and money to continue that sort of coating, because it definitely does not stand up under those conditions and we feel that the heavier coating offers a great deal better protection.

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ASSOCIATION OF IRON AND STEEL ENGINEERS, 1010 EMPIRE BLDG., PITTSBURGH 22, PA.

Application of Electronic Control

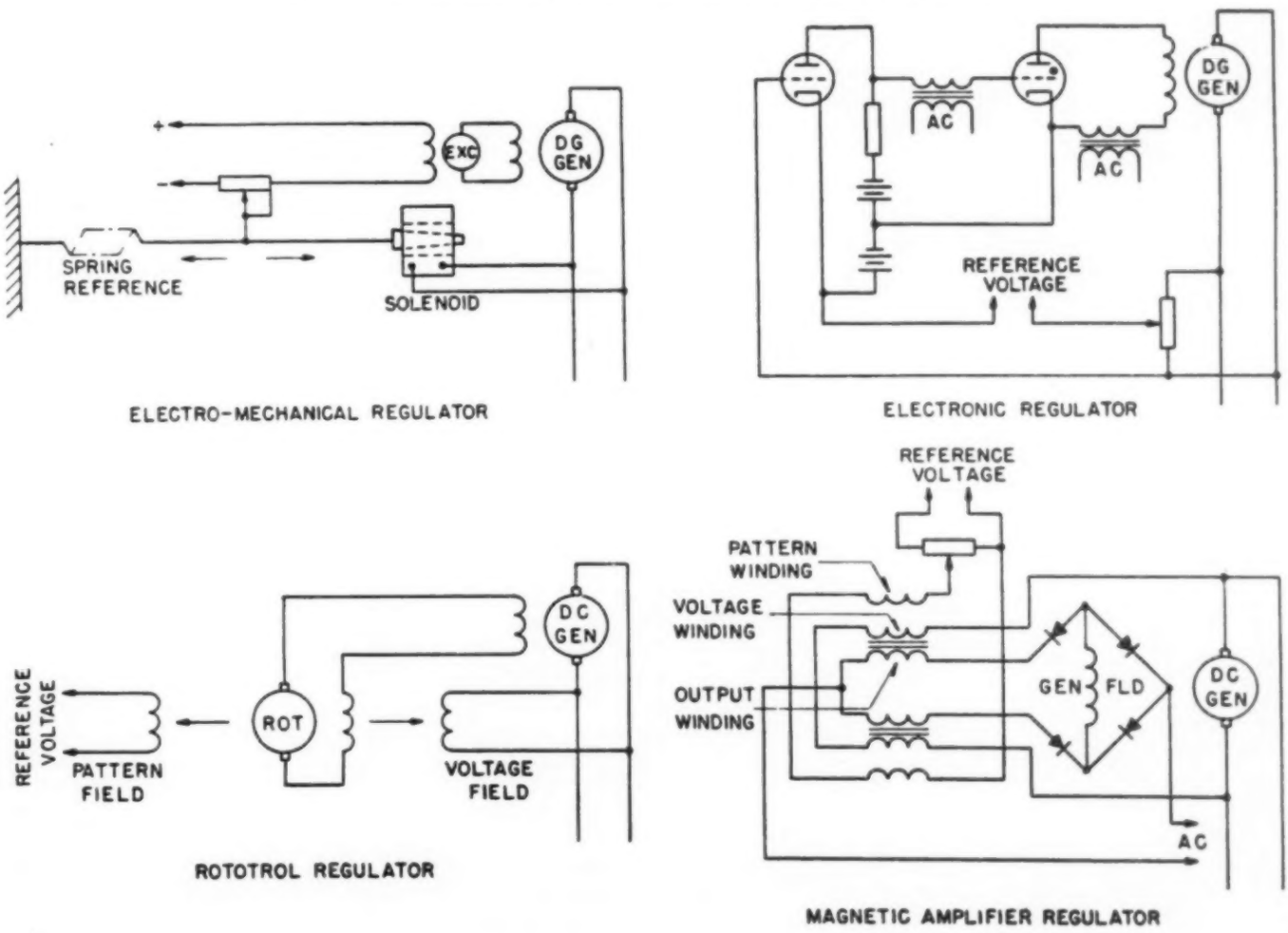
By W. R. HARRIS
Manager, Metal Working Section
Westinghouse Electric Corp.
Pittsburgh, Pa.

. . . . electronic equipment should be used when it can do a better or cheaper job, when it makes possible a process which cannot be done any other way, or when very precise or accurate control is required . . . .

▲ PROBABLY no one thing has been praised as highly or condemned as deeply as has electronics. It has been hailed as a "wonder" science and indeed it is doing some wonderful things. On the other hand some distrust the aura of mystery that surround it and want nothing to do with a "damn radio gadget" which might hinder rather than aid production.

The true place of electronics is midway between these two views. It is an important tool of the electrical designer and application engineer. Properly used, it offers distinct operating advantages and it is not surprising that a large number of installations have been made in the steel industry. The bulk of these applications do not fall under the classification of "fascinating

Figure 1 — Schematic diagrams of the four basic types of regulators.



gadgetry." In each application the engineering factors of simplicity, dependability, cost, maintenance, and availability of method, were carefully weighed before electronics was chosen. A common sense appraisal should make it clear that "electronics for electronics' sake" on the one hand, or a "No electronics for me" attitude on the other hand, should never influence the decision.

To determine whether or not to apply electronics to a particular problem, it is necessary to make a comparison with other available methods. Since one of the widest fields of electronics is in automatic regulating devices, let us compare several methods of regulating the voltage of a direct current generator.

Figure 1 shows schematic diagrams of the four basic types of regulators. All systems have one point in common—a spring or voltage reference against which the regulated quantity—in this case the d-c generator voltage—is compared. If a difference exists, the regulated system applies a correction in the proper sense and magnitude to reduce the difference. The electromechanical type of regulator uses small differences in force between the spring and the voltage measuring solenoid to move a rheostatic device which changes the generator excitation. The rotating regulator uses small differences in ampere turns between the reference and voltage fields to change the rotating regulator voltage and thus the generator excitation. The magnetic amplifier uses small differences between the reference and voltage windings much the same as does the rotating regulator. The electronic regulator uses small differences between the reference and the generator voltages to bias the grid of the vacuum amplifier tube which in turn changes the bias of the thyratron rectifier tube and thus the generator excitation. To obtain accurate voltage regulation these very small differences must exert relatively tremendous corrective effects—or in other words the amplification must be high.

Here it would be well to correct the prevalent fallacy that electronics can be made to give instantaneous correction of the regulated quantity. Actually the electronic component of the system can be made very fast —in fact faster than any other device—but it must change the sluggish field of the regulated machine which is far from instantaneous in response. The overall system including the electrical and the mechanical time constants of the main regulated machines must always be considered as must the amount of "forcing" built in to the regulator. Much more must be known about the system in addition to the type of regulator to know whether or not one system is faster than another.

Figure 2 — This 2500-kw ignitron rectifier installation for main roll drive is operating on a west coast mill.

Table I assigns comparative numbers to several points of regulator performance. The device with the smallest number would be best considering only the one comparison. No effort was made to weight individual numbers for the overall total because the weighting would change with different types of applications.

TABLE I

Comparative function	Type of regulator			
	Electro-mechanical	Rotating	Electronic	Magnetic amplifier
Simplicity	3	2	4	1
Reliability	3	2	3	1
Accuracy	2	2	1	2
Response	3	2	1	3
Use	2	1	3	4
Flexibility	3	1	1	1
Smoothness	2	1	1	1
Reverse power	2	1	2	2
Power output	4	1	2	4
Maintenance	3	2	3	1
Total	27	15	21	20

However, this total is indicative of the overall worth of the device.

From the operating man's viewpoint, simplicity, reliability and maintenance are the most important comparisons. The electronic regulator has the poorest score on these points. Undeniably, electron tubes are not as reliable as motors, transformers, resistors, etc. Tubes eventually fail, and over a long period the rate of failure will follow the usual probability curve. If the consequences of failure may be serious to either production or machinery, electronics should not be used if there is a more reliable means of accomplishing similar results. On the other hand, where tube failure may be an inconvenience, but would do no real damage, electronics should be used if the advantages gained are sufficient. Such decisions involve tube life, ease of replacement, cost of replacement, duration of shutdown, and circuit and maintenance considerations.

The importance of proper maintenance of electronic equipment cannot be over-emphasized. The electrician should be educated by training and experience to maintain electronics just as a mechanic is trained to handle expensive and complicated machinery. If either problem is attacked with vigor and enthusiasm, the results will be comparable and there should be nothing to fear with electronics.

This brings us to the question: "Where should electronic control be applied and what guide can be used in making these applications." As stated before, the engineering factors of simplicity, dependability, cost, maintenance, and availability of method, must be carefully considered. Since most electronic applications in the steel industry were made in this manner, and since the use of electronics is fairly widespread, the best guide is a review of existing installations. These can be put into three main classifications:

1. Applications where electronics can do the job better or cheaper than with other methods.
   a. Ignitron rectifiers for the direct current power supply of hot strip and merchant mills. Advantages are higher efficiency, lower maintenance, lighter foundations, and lower installed cost.
   b. The reflowing of tin by high frequency electronic power. Advantages are short work coils for easier threading and tracking, a more definite flow line, and better control of reflow.
   c. Air cleaning by means of electrostatic dust precipitators. Advantages are more thorough cleaning and less maintenance on ventilated machines.
   d. Use of ignitron contactors with electronic heat and time control for better flash welding on pickling lines. Advantages are better and more consistent welds and less weld breakage in the subsequent cold rolling applications.
2. Where electronics makes possible applications that could be achieved not at all or with the greatest of difficulty otherwise.
   a. Photoelectric loop regulators.
   b. Electronic pin hole detectors.
   c. Electronic edge control for slitting and cleaning lines.
   d. Control of the flow line on tin reflow application by means of photoelectric regulators.
   e. Non-contact X-ray thickness gages.
   f. Photo-electric safety devices.

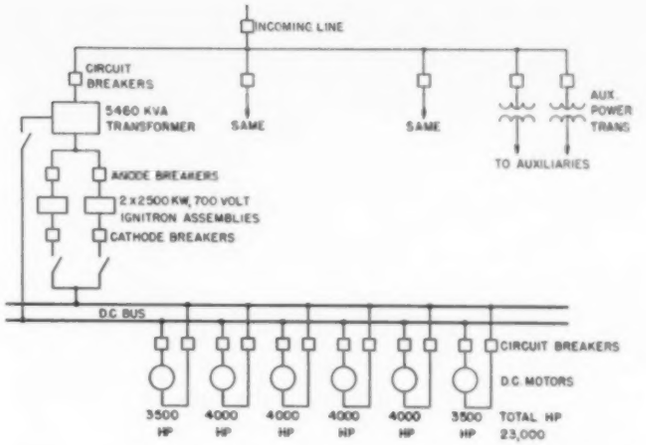


Figure 3 — Block diagram of 15,000-kw ignitron rectifier which furnishes power for finishing train of a 66-in. hot strip mill.

TABLE II

Mercury Arc Rectifiers for Steel Mill Main Roll Drive Service

No.	Year installed	Units	Total kw	Application	Mfg	Location
1*	1942	1—3000	3,000	10-in. Hot strip mill	U. S.	U. S.
2	1943	1—2500	2,500	Merchant mill	U. S.	U. S.
3*	1945	2—3500	7,000	66-in. Hot strip mill	U. S.	U. S.
4	1949	2—5000	10,000	Hot strip mill	U. S.	U. S.
5	1949	1—1500	1,500	Seamless tube mill	U. S.	U. S.
6	1949	1—3500	3,500	Seamless tube mill	U. S.	U. S.
7	1950	3—5000	15,000	66-in. Hot strip mill	U. S.	France
8	1950	3—5000	15,000	56-in. Hot strip mill	U. S.	Austria
9	1951	3—6000	18,000	80-in. Hot strip mill	U. S.	France
10*	1950	1—4000	4,000	79-in. Hot strip mill	U. S.	U. S.
11	1951	2—5000	10,000	54-in. Hot strip mill	U. S.	U. S.
12	1940	6—2400	14,400	Hot strip mill	German	Germany
13	1950	30—700	21,000	Hot strip mill	English	Wales
		Total	124,900			

*Rectifiers on items 1, 3 and 10 operate in parallel with motor-generator sets. On the other items rectifiers provide the entire finishing mill main drive d-c power supply.

3. Where a very precise and fast acting regulator component of a system is required.
   a. Rod mill impact drop regulator.
   b. All electric flying shear applications, utilizing electronic speed regulators.

To better illustrate the use of electronics a detailed discussion of one application from each group will be made.

The ignitron rectifier is a good illustration of the first classification. The typical steel plant requires a large amount of direct current power for auxiliary and main drive applications. Since power is almost universally generated as alternating current, a conversion device is needed to effect a change to direct current. Until a few years ago, motor generator sets were used exclusively for this service. At the present time, a husky electronic tube, the ignitron, is replacing the motor-generator set for 250 volt d-c power for mill auxiliaries and for large main drives such as hot strip mills where, except for starting conditions and occasional adjustment, a constant voltage direct current is required.

Table II shows the total capacity of rectifiers for main roll drives installed and on order for both domestic and foreign mills. The first three installations were made up to 1945 and it is interesting to note that two of them were for parallel operation with motor-generator sets. Operating results with these units proved the soundness of the application, and since then the trend on new installations or additions to existing mills has been toward the rectifier. Table II does not include a 24,000-kw installation supplying power to an east coast hot strip mill nor a 5000-kw unit operating in parallel with motor generator sets for a mid-western mill. These installations bring the total capacity for main roll drives alone to 153,900 kw. About 127,000 kw of this capacity has been installed or on order since the first three installations. Items 1, 2, 7, 8, 9, 10, and the two new installations totalling 86,500 kw are our equipment.

Figure 2 shows a 2500-kw installation on the West Coast with the ignitron assemblies in the background and the firing cubicles in the foreground.

Figure 3 is a single line block diagram showing the components of an ignitron rectifier rated 15,000 kw for supplying power to 23,000 hp of direct current motors driving the finishing train of a 66-in. hot strip mill. Each 2500-kw ignitron assembly consists of twelve tubes mounted on a common base. The ignitrons, anode breakers, and power transformers are located on the floor of the motor room and the rectifier heat exchangers, cathode and motor breakers, rheostats, and dynamic braking panels are located in the basement. Each of the three power transformers is supported on four steel columns. The basement area is open and less crowded than with motor generator sets which require massive foundations and space consuming ventilating equipment.

Compared to motor-generator sets the ignitron has these advantages:

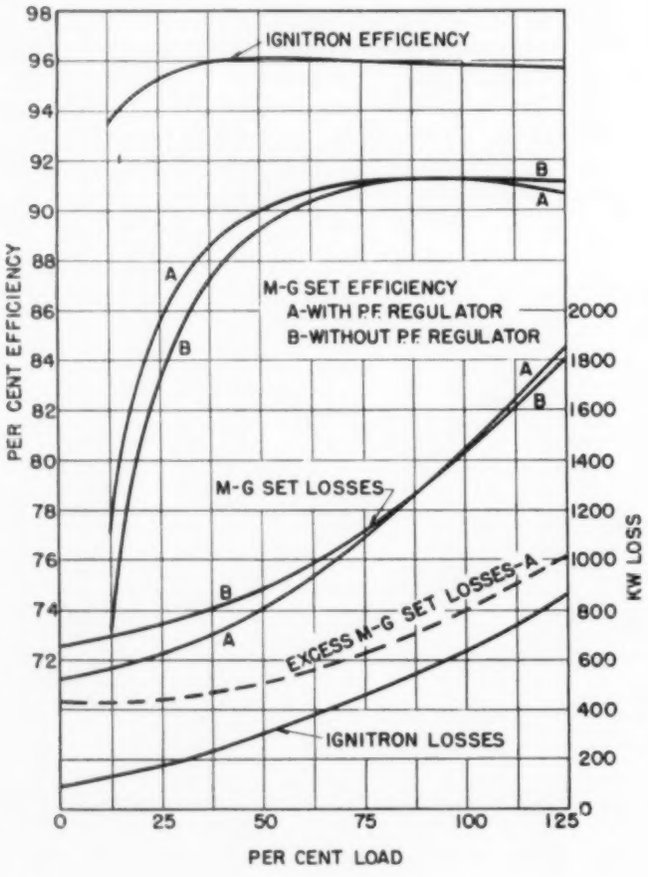
1. Higher efficiency, particularly so at light load.
2. Quiet operation.
3. Elimination of heavy foundations and ventilation.
4. High momentary overload capacity.
5. Lower maintenance costs.

Figure 4 is a plot of the efficiencies and losses of a 15,000-kw rectifier and similar motor-generator set. The important part of this illustration is the excess motor-generator set losses which with the usual hot strip mill load cycles will average approximately 600 kw. The annual power saving based on 7000 hr operation will be 4,200,000 kwhr which at 8 mils per kwhr is $33,600 per year.

In the second classification photoelectric loop regulators, which are widely used in the industry, are a good example. Figure 5 shows a looping pit on a tinning line

Figure 5 — Looping pit on this tinning line uses a photo-electric loop regulator.

Figure 4 — Comparison of efficiencies and losses of 15,000-kw, 700-v rectifier, and 90-per cent power factor motor-generator set.



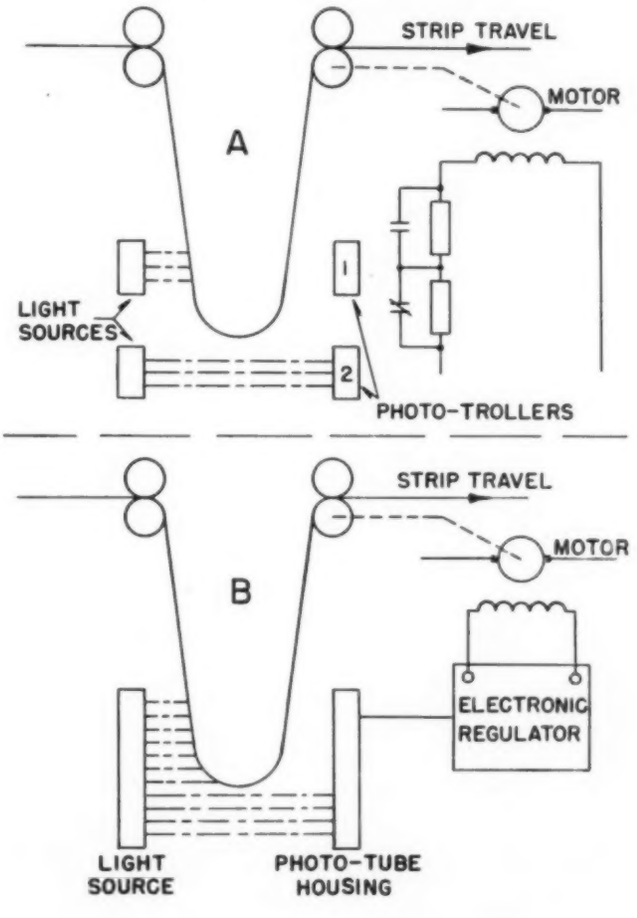
with the length of the loop controlled by a photoelectric regulator near the bottom of the pit.

In early applications when the line speeds were relatively slow, photoelectric loop regulators consisted of one or more photoelectric relays operating in the control circuit as limit switches. An example of this is shown in the A position of Figure 6. The system is designed to keep the loop between the two phototrollers which consist of a phototube, an electronic amplifier, and a relay operating in the control circuit. If the loop gets above Unit 1, the motor driving the pinch rolls will be slowed down by relay action. If the loop fails below Unit 2, the motor will be speeded up by relay action.

As line speeds increased, the problem of loop control became more difficult due to the high rates of correction required, higher stored energy in the rotating equipment and wider operating speed ranges. Figure 6B shows the modern photo-thyratron loop regulator installed on many of the high speed processing lines today. The light source consists of a long fluorescent tube. Two photocells are arranged with the electronic regulator to give continuous smooth correction with change in loop length. In the last four years our company alone has built more than 50 such units.

Another interesting application under the second classification are the edge regulators employed on modern high speed side trimming and cleaning line applications. Figure 7 shows such a device which is located immediately after the pay-off reel of a 3000-fpm side trimming line. The edge detector is shown between the two guide rolls and it furnishes the signal to the electronic regulator which runs the hydraulic pump motor for the pay-off reel shifting mechanism.

Figure 6 — Block diagram of discontinuous and continuous photo-electric loop regulators.



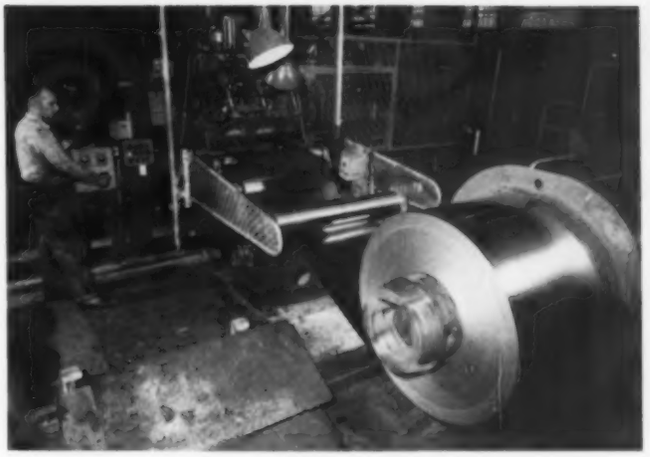


Figure 7 — Edge position photo-electric regulator shown is applied to a 3000-fpm side trimming line.

One of the best illustrations in the third classification is the electronic regulator used on the all-electric flying shear. In the past, the flying shear was driven and synchronized to the last finishing stand through a complex mechanical or hydraulic system with separate electric motors to accelerate the shear. These units were cumbersome, maintenance was high, and they were not easily adjustable for different cut lengths. The all-electric flying shear simplifies the equipment thereby reducing maintenance and tests have shown it to be more accurate than with older forms of drive.

When the accuracy required of a flying shear is studied, it is not surprising that there was some scepticism as to whether or not an all-electric drive would give successful operation. For instance, if the length of cut is 25 ft and the allowable variation is 1 in., the maximum error which can be tolerated is ⅓ of 1 per cent. The duty on the regulating system is further complicated because of the necessity of bringing the shear from rest to full speed as quickly as possible without perceptible overshoot. The high accuracy and quick response features of electronics and the ease with which damping and anticipation circuits can be utilized made it a natural selection for the flying shear regulating system.

A schematic diagram of the all-electric flying shear drive is shown in Figure 8. A speed indicating pilot generator is mechanically connected to the last finishing mill stand and its voltage is bucked against that of a duplicate speed indicating generator coupled to the shear drive. Any difference in voltage between the pilot generators is amplified through the combination electronic-rotating regulator to increase or decrease the shear speed as required. Cut-length adjustment is by means of a small rheostat located in the operator's pulpit.

The unsolicited comments of the superintendent of a large cold strip rolling operation, on the use of an X-ray gage for measuring strip thickness, are a fitting closure for an electronics paper. As closely as can be remembered they are:

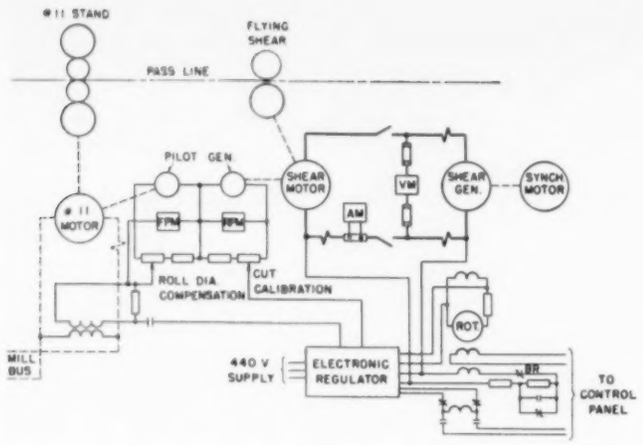


Figure 8 — Schematic diagram for all electric flying shear drive.

"At first I was very reluctant to operate with the X-ray gage only, and continued to use the mechanical gage on one side of the strip and the X-ray gage on the other side. At times there was a wide variance between the readings of the two gages and, hard to believe, every check made indicated that the X-ray gage was actually reading exactly what it saw. Complaints from the shearing dept. about 'over and under gages' were materially reduced as we gained more confidence and became more dependent on the X-ray gage rather than on the mechanical gage."

If electronics is applied as it should be—not where other devices are more suitable—it has a bright future in the iron and steel industry.

DISCUSSION

PRESENTED BY

G. DE CROCE, Consulting and Application Engineer, Westinghouse Electric Corp., Pittsburgh, Pa.

G. W. BAUMGARTEN, Electrical Engineer, United States Steel Co., Edgar Thomson Works, Braddock, Pa.

G. DeCroce: I want to bring out a point that probably has been missed in all of this discussion. You start out by talking about electronics being a gadget, but actually it is out of the gadget and blue bottle stage. It has become a piece of equipment that can be reliably used. I would like to cite one illustration where electronic equipment has proven itself, it is the Pennsylvania Power Co.'s electronic exciter installations at Warren and Seward. These people had faith in electronic equipment. The design was made to meet this application. The equipment has been in service now for over two years. There are no other exciters, there is no spare rotating exciter to augment the electronic exciter, it is there by itself. The units at both Seward and Warren have been in operation for over two years and they have had no tube failures. The primary reason for this is the fact they have trained maintenance men who know electronic equipment.

You cannot use the ordinary screwdriver and plier electrician to maintain electronic equipment. He must know something about electronics, just as he must know something about a motor.

Electronics really is still in its infancy and the iron and steel industry is probably a little slow in accepting it. They have been accustomed to dealing with large contactors and large equipment, and they think in terms of large equipment. They look at a tube and think of it as being something that is a fragile device. Actually it is no more fragile than the contactor or the motor, when it is applied within its rating. That is the important point. There would be no point in using a ten-ton truck to haul a one-ton load. Therefore, if you apply electronic equipment within its rating it will give a good account of itself.

I cite another example. We in our own plant have accumulated a tremendous amount of electronic equipment and we also have fallen into the same pitfall that most people do, and that is we take the ordinary electrician and say: "Go out and maintain this equipment." He tries, but fails. He does not know what it is all about, so he guesses "it must be a tube," changes the tube, and finds it is not the trouble. He wastes time and then calls for help. An engineer is then sent to clear the trouble and usually finds it is something quite simple. As a result, we are conducting a course for these men, teaching them the fundamentals of electronics, and I think with that teaching there will be less down time. There is no reason why there should be much down time.

In connection with test equipment, you can get by with an ohmmeter and an oscilloscope. That is actually all that a man trained in the art requires to give reliable service.

I am sure you must appreciate electronic equipment is beyond the stage of being a toy. The manufacturers have learned that this type equipment must be made reliable, they have found the limitations, and they are building equipment that can be depended upon.

Mr. Harris stated that an electronic regulator is fast, but that you are required to deal with other parts of the system that are somewhat slow. I think the point here is that you must go beyond that, because the electronic equipment itself will not do it alone. However, I see no reason why you cannot do what the electric companies have done, go whole-hog, and in that way you can get low maintenance and reliable service.

G. W. Baumgarten: The electronic equipment that we have is relatively simple, in that it consists of the first 250-volt rectifier that was installed in 1939 in a steel mill. Since that time we have installed several communication systems. Maintenance has been simplified by having the various amplifiers made drawer type, so when one fails there is a spare available. We unplug the one that has failed and take it back to the shop and work on it. Our plant also contains a 20,000-kva automatic electronic frequency changer which requires 48 GL-506 electronic tubes rated at 200-amp and 6000-volt. This installation has been described in detail in previous publications of the AISE.

Designing Electronic Equipment for Minimum Maintenance

. . . . maintenance on electronic equipment can be kept to a minimum if attention to maintenance requirements is considered in the original design . . . .

By ANTHONY P. DiVINCENZO
Control Development Engineer
Reliance Electric & Engineering Co.
Cleveland, Ohio

▲ ELECTRONIC tubes and circuits have certain inherent characteristics which are difficult or even impossible to duplicate by other electrical or electromechanical means. Because of these characteristics, electronics has become an important tool for the industrial control designer, and have found entrance into the design of chemical, textile, mining, metal processing, and business equipment. Because of its versatility and flexibility, electronics should be seriously considered in the design of industrial control equipment used in connection with rotating electrical machinery. On the other hand, a designer should not go overboard and use electronics at every opportunity solely because it is his newest and most fascinating tool.

Electronic equipment for industrial control is usually used in conjunction with rotating machinery and its associated magnetic control. As such, it is considered an integral part of the control and is being applied under the same wide range of conditions. It is expected to perform under extreme variations of temperature and humidity, in corrosive and sooty atmospheres, under conditions of continuous vibration and shock, and to withstand abuse when being handled. The designer then, must, to the best of his ability, produce equipment which will be as rugged, reliable, and perform as well or better than, the machines or devices with which it is to operate.

Since much more is expected of industrial electronic control, the designer has an entirely different problem than the designer of a home radio which to most people signifies electronics. The first considerations of a radio designer are first cost and adaptability of his design to mass production methods. Reliability is of secondary importance, and maintenance and servicing are lightly considered.

On the other hand, a designer of industrial electronic equipment must consider reliability first. He must design equipment which can be serviced easily and quickly by one who has a limited knowledge of both the circuits employed and electronics. He cannot pass the buck on maintenance and servicing as is usually done with radio sets, since down time of the equipment must be kept to an absolute minimum. He must then produce equipment which is far superior in quality to the ordinary home radio.

In designing industrial electronic equipment, there is much the designer can do to produce a dependable device which will require a minimum of maintenance. What are some of the factors over which the designer has control and which he can use effectively to produce equipment of the high quality required? Some of the most important and those to be discussed briefly are:

1. Selection of components.
2. Mechanical design.
3. Component limitations.
4. Simplicity.

SELECTION OF COMPONENTS

Most electronic equipment manufacturers are dependent on sources of supply outside their own organization for component parts. Since the termination of World War II, the designer has had available a wider variety of better components from more sources than previously. The wide use of electronic equipment by the armed forces has not only increased the number of suppliers and the quality of components, but has also resulted in a standardization of component specifications and test methods. This has been brought about by strict adherence to the Joint Army and Navy, JAN, Specifications, which suppliers were forced to meet. The inadequate line of "radio type" components formerly available are being replaced by a more rugged, and more conservatively rated line of components.

Resistors—Since electronic tubes are high-impedance devices, the resistors associated with the circuits are high-resistance, low-wattage components. In keeping with industrial control practice it would be preferable to use wire-wound resistors. But high resistance units use very fine wire, so that a compromise has to be made.

For resistances up to 20,000 ohms, a wire wound resistor of 10-watt rating is used. The 10-watt rating is selected not because the tube circuits require the wattage, but because it is a rugged, well rated, and well insulated, wire wound resistor of moderate size. Seldom, if ever, is the wattage rating approached in usual circuit design. The resistance wire of the unit is completely covered in a fixed, fired, vitreous enamel similar to that used on standard industrial control tubular resistors which have been used for years. The vitreous enamel gives a tough, hard, moisture and acid resisting covering with high heat conductivity.

For resistances of 20,000 ohms and up, molded composition resistors are used. These resistors have been

found superior to the fine wire-wound resistors of the vitreous enameled type. Usual practice is to use either 1-watt or 2-watt resistors throughout the design. Two-watt resistors are used from 25,000 to 100,000 while the one-watt size is used from 100,000 to one megohm. A 100,000-ohm, 1-watt resistor must have 320 volts applied across it to reach its one-watt rating. A 50,000-ohm, 2-watt resistor requires an applied voltage of 320 volts. Since the usually available vacuum tube power supply is either 150 or 300 volts, it is seen that the full wattage rating is seldom approached even if the resistors were placed directly across the power supply which of course is rarely done.

The molded resistors will operate satisfactorily over a temperature range of minus 60 C to plus 70 C. They will sustain an overload of ten times rating for a considerable period of time without failing. They are made of an inert resistor material so changes due to moisture are negligible and they will pass water immersion tests.

For resistors larger than 10-watt capacity, the usual wire wound, vitreous enameled resistors common to industrial control circuits are used. When an adjustable resistor is required, it is common practice to use vitreous enameled resistors of fairly heavy wire of either 25 or 50 watt capacity, even though the wattage rating is not required.

Potentiometers—Potentiometers are used in electronic equipment as operators controls or adjustments. If used as an operator's control, the designer can arrange the circuit so that it has a low resistance value. Then it is possible to use an all porcelain vitreous enameled potentiometer such as used in other industrial controls.

Smaller space saving potentiometers are used for front of panel adjustments which require field adjustments. Up to 25,000 ohms, 2-watt wire-wound completely housed potentiometers are used. But these must be insulated from ground to withstand the 1500-volt insulation test. Four-watt potentiometers of more rugged construction which can withstand the 1500-volt to ground test are now becoming available.

For potentiometers with resistance values of 50,000 ohms and up, a molded resistor type is available. The resistor material is molded with insulation, terminals, face plate, and threaded bushing into a single unit. No rivets, soldering, or welded connections are used. Simple construction and few parts make a reliable unit which will not be affected by moisture and will operate satisfactorily over a temperature range of –60 to plus 70 C.

Capacitors—The capacitors used in industrial electronic circuits are high quality paper capacitors in hermetically sealed cans. These capacitors are oil-impregnated and the cans are filled with mineral oil or its equivalent. They give dependable service over a wide temperature range of minus 55 to plus 80 C at approximately rated voltage. It is usual practice to use capacitors rated at 600 working volts, d-c throughout the design and this rating is approached on only a few rectifier circuits.

The low-cost wax impregnated capacitors found in radio and television sets are not used at all. Electrolytic capacitors are seldom employed, and when they must be they are used well below their rated voltage on d-c which is the easiest type of service for these capacitors.

For capacitance less than one-tenth microfarad, smaller space saving tubular types are used. These are also metal cased, hermetically sealed, mineral oil impregnated and rated at 600 volts.

For industrial control service the drawn-can capacitors have added insulation between the capacitor and the can so that they can withstand the 1500-volt to ground insulation test.

Transformers and inductors—Transformers and inductors used in industrial electronic equipment are of special design and of quality construction. They are wound with enameled wire, pre-heated, dipped in a polymerizing varnish and baked. This is exactly the

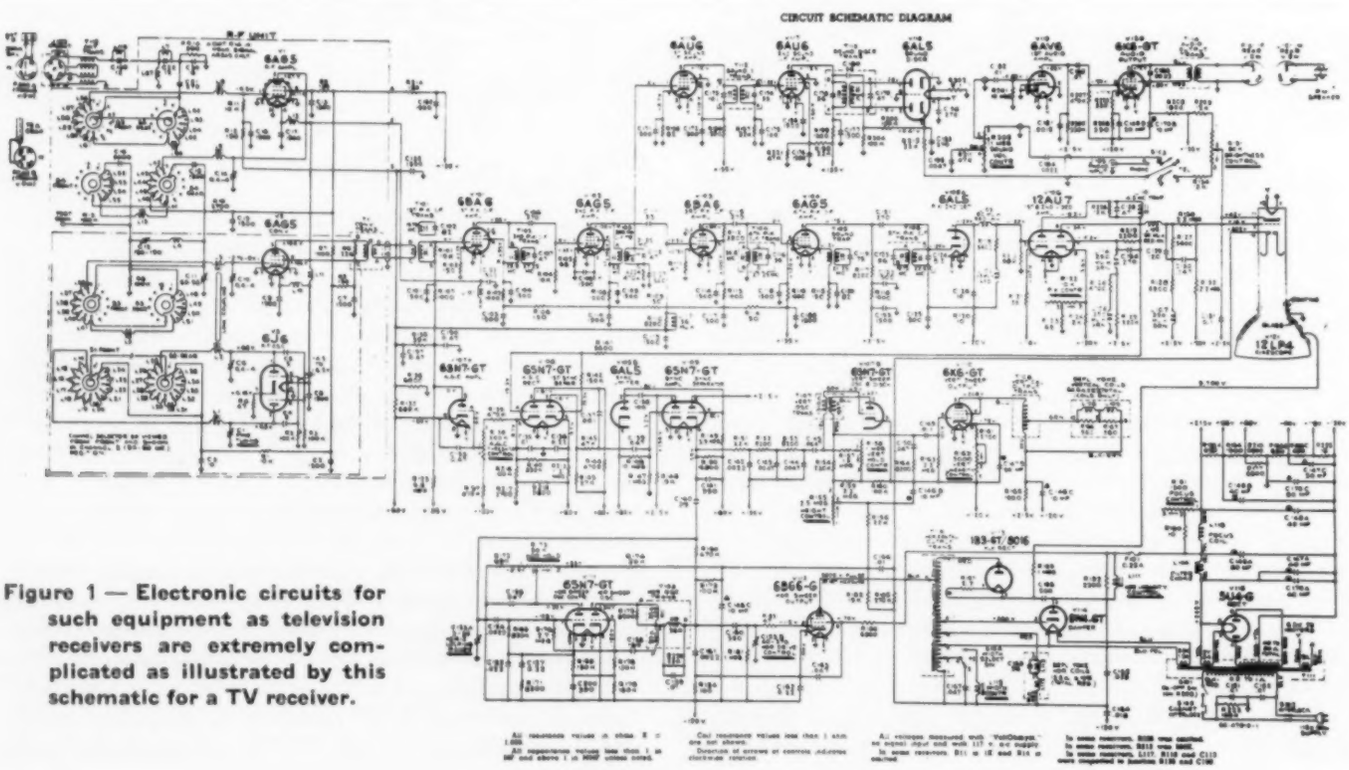


Figure 1 — Electronic circuits for such equipment as television receivers are extremely complicated as illustrated by this schematic for a TV receiver.

same process used for field coils of rotation machinery. In addition they are layer wound with added insulation between layers, and are designed for a 55 C temperature rise above a 40 C ambient.

For most transformers, the laminations are bolted together with angle iron, which also affords a convenient and sturdy mounting means. Terminals are brought out on a separate terminal board or secured to a stiff insulating material which is part of the windings.

MECHANICAL DESIGN

Most industrial electronic control equipment is mounted on steel panels which afford a very reliable means of anchoring the components. Fuses, tubes, and adjustments which may have to be made in the field are placed on the front of the panel. Factory adjustments together with all the other components are placed on the rear of the panel.

Much can be done in the layout of a panel to make it appear relatively simple. Parts should be located with good spacing and sufficient electrical clearances. Wiring should be neat and well placed. Terminals as well as component parts should be well marked. Small components such as resistors and tubular capacitors should be mounted on terminal boards making them readily accessible.

It is probably safe to say that panel layout and wiring can make the electronic device a success or a failure. Haphazardly placed components and "rat nest" wiring leads to considerable confusion and reluctance of personnel to service the equipment. Such panel layout can easily lead operating personnel to believe that the device is too complicated to work satisfactorily.

COMPONENT LIMITATIONS

As in the design of most industrial control equipment, the designer in most instances selects components which are conservatively rated. Because of the many small, rather inexpensive components which go into an electronic device, the designer of industrial electronic equipment can go one step further and use his components at values much less than the maximum rating without adding appreciably to the first cost of the equipment.

As has been previously mentioned, resistors used will hardly ever reach 50 per cent of their rating. Capacitors, even though a reliable component, will seldom be operated at their rated voltage. In this connection, the good designer will rarely exceed twenty-five per cent of rating on a vacuum tube. By so doing, the life of the vacuum tube is substantially increased.

Industrial gas-filled rectifier tubes are conservatively rated, and usually operated near their rated value. Some difficulty has been experienced with these tubes, but it has not been entirely the fault of the tube. One such application is power conversion where the tubes are used to replace motor-generator sets. Since the tubes are efficient devices their thermal capacity is limited, and consequently they cannot withstand a sustained overload of 200 to 400 per cent like a motor-generator set. If a designer then sets up his circuit so that it supplied a known load such as a motor or generator field, such difficulties will not arise.

In employing vacuum tubes, the designer must consider the change in tube characteristics between tubes, and with tube aging. If in order to overcome this difficulty, the circuit must be readjusted for tube replacement or aging, then there may be no advantage in employing electronics. There are means of surmounting this difficulty in either the control or electronic circuit design. One such means, for example, is the use of negative feedback circuits.

For best results, an electronic tube should have its cathode operate at its rated temperature. In order to secure such operation a good designer will use constant voltage transformers to maintain a constant filament voltage on all tubes. Transformers which will maintain the secondary voltage to within one or two per cent of its normal value with a fifteen per cent change in primary voltage are available. Not only will this greatly extend tube life, but it will also eliminate one cause of changes in tube characteristics.

By far the greatest cause of failure in electronic tubes is heater burn-outs, due largely to the application of rated filament voltage to a cold heater. With the use of constant voltage transformers as a sola, the inrush current cannot exceed 125 per cent of rated value and thereby cannot create excessive cathode currents on starting.

In connection with heater burn-outs, it has been found that the low voltage filament tubes have far less heater burn-outs than tubes with high filament voltages. Tubes with 6.3-volt heaters or less are more desirable and should be employed.

In some applications where the equipment is to be operated on a twenty-four hour a day basis with very little time alloted for maintenance shut-downs, electronic equipment has been designed which will allow tube checking as well as circuit checking while in operation. This has been accomplished by using dual tubes and paralleling triodes or diodes in different envelopes, and by special circuit design. Thus no one tube or its circuit is critical, and either failure or removal for checking will not cause a temporary shut-down. This type of design has been done in only a few applications where standby equipment is usually employed. The important factor is that it was done with a moderate increase in first cost and circuit complexity compared to a wired-in standby unit.

High impedance circuits normally associated with electronic tubes have been a source of trouble due to leakage currents, and stray coupling which can upset the control. Whenever possible, the designer must reduce the impedance of circuits to a minimum and also obtain isolation between circuits as far as possible.

SIMPLICITY

One of the most important factors an electronic control designer must consider is simplicity of the basic circuit scheme. If the electronic circuit required to do the job is too complex, then it should not be done electronically unless no other means are available. In some cases the basic scheme may be simple, but if additional conditioning circuits, and conditioners to the conditioners must be added to overcome, say tube limitations, then again it is not advisable to undertake the control electronically.

Actually most industrial electronic control circuits are relatively simple compared to say, a radio, or television circuit. Such a device probably has a hundred circuits, and is equivalent in circuit complexity to quite a large switchboard. Figure 1 is a circuit diagram of a typical television receiver. Its circuit consists of oscillators, amplifiers, multivibrators, discriminators, plus shapers, rectifiers and numerous resonant circuits. Circuits for industrial electronic control usually consist of a few stages of both voltage and power amplifiers. Figure 2 is the line diagram of a typical industrial control circuit. It is an electronic regulator used on a fritzmoon continuous tube mill to synchronize the speed of the saw carriage to the last mill stand, so that an equal length of tube is cut automatically even though the line speed is varied.

The signal for the regulator is the difference voltage between two tachometers, one driven by the last mill motor and the other by the saw carriage motor. If the saw carriage speed changes, a voltage signal is supplied to the regulator which is amplified by the first and second tubes. The output of the second tube then controls a thyratron rectifier which supplied excitation to a buck-boost generator in series with the saw carriage motor armature. The buck-boost generator then modifies the saw carriage motor speed until the tachometer voltages are equal.

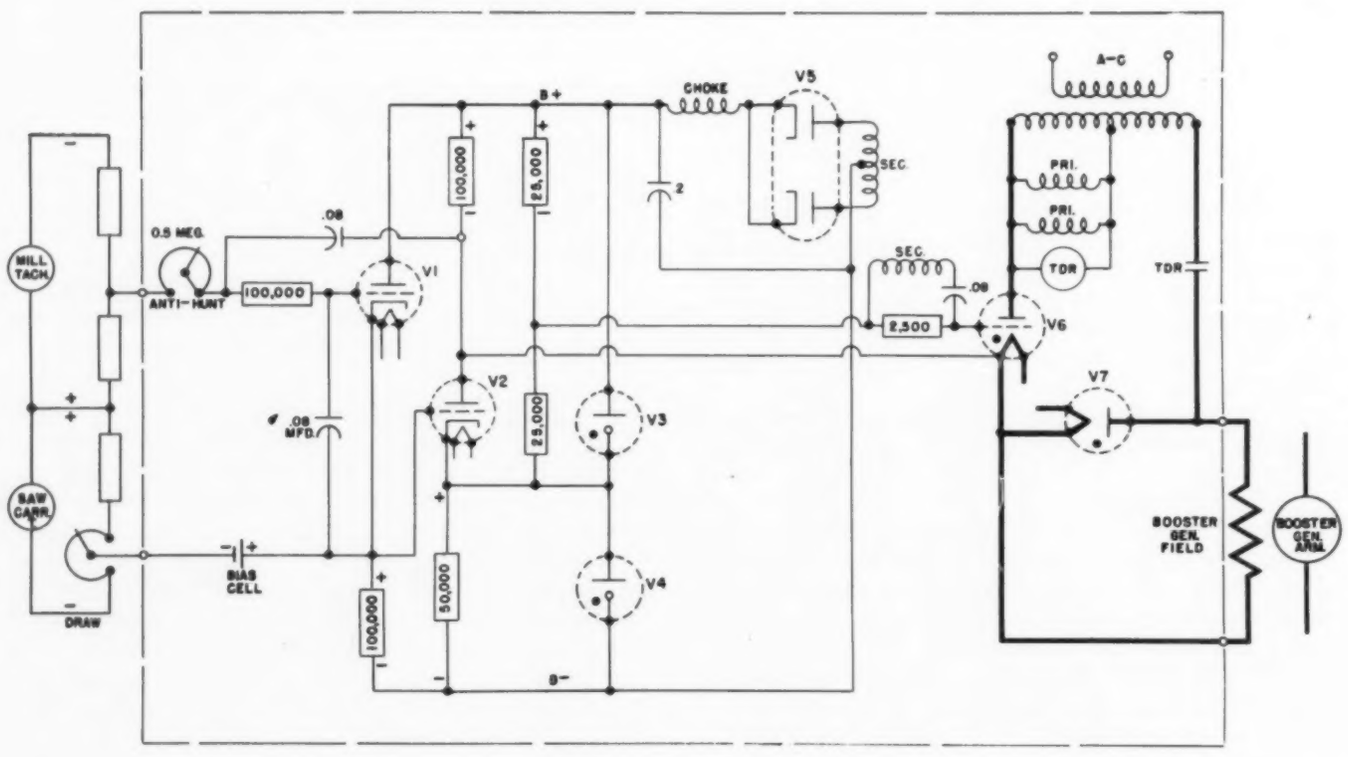
With the two vacuum tube amplifiers and the thyratron rectifier, the voltage gain obtained in the regulator is approximately 10,000. The power gain of the regulator is considerably more since the grid of the first tube is operated with a negative bias and draws a negligible current.

Note that the only adjustment on the regulator is the anti-hunt adjustment. Changes in tube characteristics may change the operating bias on the first tube a few hundredths of a volt, but this has little effect on the accuracy since this change is a fraction of an rpm on the 100 volt per 1000 rpm tachometers employed. The rectifier supplies a generator field of known value so that there is no danger of overloading the rectifier tubes.

Figure 2 also shows how an electronic circuit can be drawn in a manner very similar to a control line diagram. But in electronic diagrams the supply lines are drawn horizontally instead of vertically. Tube plate circuits are drawn in line and vertical similar to coil circuits. The components' symbols are located in the diagram physically in proportion to their potential level to help determine potential magnitudes at a glance. Related components are grouped in the diagram so that circuit functioning and sequence can be traced through the diagram step by step which is helpful in understanding how the device works.

In connection with circuit simplicity, it should be pointed out that a thorough understanding of the circuit is not essential to properly maintain and service equipment. For example, it is doubtful whether commercial radio or television servicemen know exactly what function all components perform in the circuit. Yet, they evidently are capable of performing fast and efficient service otherwise they would not be in business. In order to service and maintain industrial control equipment, the essentials one needs are a knowledge of a few basic tube circuits, good simplified line diagrams, a table of various circuit voltages, and maintenance and service suggestions by the manufacturer. As far as basic tube circuits one must understand, there are two in particular which are used in 75 per cent of industrial control circuits. The basic triode tube circuit and how

Figure 2 — Electronic equipment for industrial control have simpler circuits than those in radio equipment. Circuit shown is for electronic regulator on continuous tube mill.



a vacuum tube amplifies is one basic circuit, while the other is the basic thyratron circuit and the methods of grid control for making the tube perform as a fast switch.

In conclusion, if the designer gives proper consideration to the factors discussed he can produce electronic equipment satisfactory for industrial use. There are today, numerous electronic equipments in industrial service which have given the required operation for years. As more people become familiar with the limitations and proper application of electronic equipment, it will be more widely accepted and used to advantage to solve the ever increasing number of control problems which are being encountered every day.

DISCUSSION

PRESENTED BY

Member: A few years ago I was discussing electronics with an electronic engineer at a broadcasting station. We were discussing relays and the values of relays and how large they were, and he mentioned about having a beast of a relay. He said, "It's a beast of a relay," and when I asked him how large it was, how much current, he said, "It's good for five amp." After working with steel mills for several years, I thought that as long as electronic engineers think of five amp relays as being beasts of relays, then it is going to be hard for an electronic engineer and the man that works in the mill ever to get together, because he works with a 100-amp relay, a 1000-amp relay, and so on.

From the way these authors have talked, we have been offered what we have asked for for several years, a resistor large enough to carry our current. We must realize that they built radios to sell for $18.95, then $8.95, and I do not know how low they went. We started out in the steel mill with a resistor that cost perhaps five or ten cents and it might cost us a thousand dollars to replace that when it failed. We have found in the past few years that we have been getting the resistors that would not burn out, and we were charged first cost, which is minor compared to delay cost.

The motor inspector cannot keep up this equipment. In fact, the old time motor inspector is no more. He disappeared when you gave him a booster to go on the motor. He went far in the background when you gave him a booster for the booster. But later on when you gave him a booster for the booster for the booster, and a rotating regulator for good measure, then he disappeared. He had to go to work. The men that design electronics know it from one end to the other. One of the biggest compliments that engineers pay to the men in the mills is to design and build complicated equipment, and then give it to the men in the mill and expect them to operate it. This, most of the time, he does. Very seldom does he call back to have it tuned up. That does not mean the manufacturer does not build equipment that has no trouble for he does.

Maintenance of Electronic Control

. . . . the key to good maintenance of steel plant electronic equipment lies in properly trained maintenance men . . . .

By O. P. ROBINSON
Cutler-Hammer, Inc.
Pittsburgh, Pa.

▲ IN order to develop information on the maintenance of electronic equipment in industrial plants, we have talked to maintenance staffs in a large number of the plants in the Pittsburgh area. Our investigations have brought to light the fact that the most important tool involved in this maintenance work is a man.

We found that in practically every case, men have been assigned to this work who have had some training in radio or public address systems. These men have been selected by the maintenance supervisory staff to handle this work, and there is definitely a shortage of such men. In many cases, we found that only one man was available for all three operating turns at the plant. This of course has thrown a great deal of the responsibility for the keeping of electronic equipment in operation, on the maintenance supervisory staff where these men are electrically trained, and on the electrical engineering staff in those cases where the maintenance staff are not trained electrical men.

This all adds up to the fact that any maintenance that is done on electronic controllers is done by people who could not be said to be trained people. It requires a pretty high type of labor to understand the complexities of the electronic circuits, to say nothing of the knowledge of the values of resistor and capacitor units which make up a very large part of the electronic system.

To offset this, however, there is an advantage to electronic control in that the day to day maintenance is not very much, consisting mostly of the replacing of relay contacts and occasionally a burned-out tube. The controls seem to run for long periods of time with no other maintenance except this.

It is during the times when real trouble develops on the controller, such as burned out resistor units or defective condensers which causes the circuits to react improperly, that the great burden falls on the supervisory staff.

Since the contactors and relays used in this type of control are the same as that used in conventional con-

trol, the maintenance problem presents no difficulty. It may be said therefore that the maintenance problem on electronic control consists in the maintenance of the tubes, their sockets, the resistor units, condenser units and the wiring of the circuit itself.

TUBES

One of the most common practices among men who are assigned to maintenance of electronic equipment, is to assume that something must be the matter with the tube or tubes and to search for one which appears to be slightly different in brilliance or color than the others and replace it. Many good tubes are wasted in this fashion. One of the most important things that we have discovered in our talks with maintenance departments is that if a tube lasts for the first day or two after it is put in service, it will last for a long time. The manufacture of these tubes is a tricky proposition, and there are a large number of rejects. In testing the tubes before they are shipped, some of them will pass the test inspection, but will not stand a matter of eight or ten hours of continuous burning, and therefore burn out or fail very early after being installed in service. Care should be taken therefore to watch new tubes after they are installed for two or three days and if they last this long without giving trouble they will probably last a very long time.

Because of the wide current ranges and construction of tubes, it is very difficult to have any test apparatus on hand with which to test these tubes, and it is found that the best way to test the tubes is in the circuit itself. We would like to point out, however most emphatically, that changes in resistor values, condenser capacities and even in voltages can change the appearance of a tube when it is burning enough so that some maintenance man may consider it as having failed, and discard it for a new one when the trouble is elsewhere. Much money can be saved in tube replacements by watching this particular point.

RESISTORS AND CONDENSERS

Most electronic circuits are set up with a tremendous number of small resistor units and condenser units, and these are the most common elements of electronic controllers to cause failures. They can of course be easily checked, but in order to do this, a trained man is required to know which ones to check. A good stock of resistor units and condensers should be kept on hand in the storeroom for replacements of these items.

TUBE SOCKETS

A considerable number of trouble cases on electronic circuits are due to the annealing or misalignment of the prongs in the tube sockets, causing high resistance connections or no connection at all, and these cause failures of controllers. A good maintenance man checks these contact points occasionally. We have seen maintenance men put a small drop of solder on a tube prong in order to get better contact of the tube prong with its connector.

WIRING

Wiring should be checked for loose connections, since high resistance connections can cause incorrect operation. Pushbuttons and limit switch connections, as well as the contact devices in the pushbuttons and limit switches, can cause incorrect function, and in cases of trouble these should be checked immediately so as to make sure the trouble is definitely on the electronic control equipment itself. In many cases trouble is suspected in the electronic equipment when actually it is in a bad contact in a limit switch or a pushbutton circuit.

CONSTRUCTION

Perhaps the greatest help to keeping electronic equipment running can be added in the construction of the equipment itself. Tubes should be mounted so that they are easily replaceable, and the condenser and resistor units and wiring on the back of the board should have extra care in its construction. Electronic circuits are very difficult to trace at best, and the resistor units and condensers should be mounted so that connections can be taken apart so that these items may be tested. It appears to be common practice now, to bring the wiring to a terminal block and to connect the resistor and condenser units to terminal studs rather than to merely make a pigtail twist and solder the connection. This enables the maintenance man to isolate individual resistor and condenser units and thus check them easier.

In considering electronic controllers of the wall mounted type, we believe it is usual practice now to mount this equipment on a steel panel and arrange the panel on hinges so that it can be swung clear of the case, so that both the front and back of the panel may be handy.

In large panels of the floor mounted or switchboard type, the electronic apparatus is usually mounted on small sections which are removable and connected to their circuits by a plug device on a flexible cord. This enables the maintenance department to carry spares, and instead of attempting to find trouble on one of these panels, they merely change the whole panel and determine the trouble at their leisure.

INSTRUMENTS

In talking with maintenance men in various plants, we have found that the most useful instrument to have is one of the type which combines an ammeter, voltmeter and ohmmeter. With one of these instruments, you can check amperes directly up to 5 amperes, and by the use of current transformers, to an unlimited degree. The voltmeter portion usually has a dial tap changing switch which will allow voltages to be read up to about 1100 volts. Eleven hundred volts is a standard or common voltage to use on grids, so the instrument should have a reading of this magnitude.

The ohmmeters supplied in this type of instrument usually read up in the megohms with dial switches for different connections of a Wheatstone bridge, and will give very accurate measures of resistance for checking the resistance units. One of these instruments is an

important item of the maintenance man's tools and should be on hand.

RENEWAL PART AND MAINTENANCE INFORMATION

Most control manufacturers, who supply electronic equipment, supply an instruction book for use by the maintenance men, telling of the circuits and the correct method of operation. More important than this, however, they supply the ohmic values and condenser values of the items on the back of the panel so that these units can be replaced in the correct amount. The maintenance man should see that he has this information on each electronic controller under his care.

SUMMARY

We realize that the above does not give much in the way of helpful hints on the maintenance of electronic equipment, but our discussions with maintenance departments indicate that there is not a great deal of information available, and that the key to maintenance of electronic apparatus is still a man's brain. Nearly all the cases of trouble are not so much with the apparatus as in having men with training enough and engineering ability enough to follow out the circuits and determine the trouble. Fortunately these troubles do not happen very often, and probably can be taken care of by the supervisory staff when they reach the point where the shop electrician cannot lick it by replacing a tube or a resistor unit.

DISCUSSION

PRESENTED BY

A. P. DI VINCENZO, Control Development Engineer, Reliance Electric & Engineering Co., Cleveland, Ohio.

A. P. DiVincenzo: Since Mr. Robinson has referred to my electronic regulator circuit (Figure 2) as an example of complex electronic circuitry, I would like to make a few comments. In my paper I attempted to stress the point that electronic circuits for industrial control can be made very simple if the designer makes a serious effort. In fact, electronic circuits can be made as simple as the ordinary contact and coil series circuit.

Mr. Robinson commented that the regulator circuit is not complete. I would like to state again that the circuit is at least 90 per cent complete. A resistor-capacitor filter for the thyratron grid, a voltage limiting resistor for the voltage regulator tubes V3 and V4, and another filter capacitor across the d-c signals for the thyratron are the actual components that are missing from the diagram. It is true that the complete tube filament circuit is not shown, but the tube filaments are all connected directly to a common filament transformer. There are no resistors, capacitors, or additional adjustments in the filament circuits. The anti-hunt is the only adjustment on the panel.

The regulator circuit is drawn as a control line diagram. Instead of the two parallel supply lines running vertically as in control line diagrams, they are drawn horizontally as B plus and B minus. Each tube plate circuit is then drawn vertically between the supply lines. For example, tube V1 and its 100,000-ohm plate-load resistor comprise the plate circuit of this tube. Thus, if the electronic circuit is properly drawn, it can be made exactly like the control line diagrams with which we are all familiar.

In regard to electronic tubes, it is true that what goes on inside the tube may be a complex phenomena as Mr. Robinson has stated. But in order to apply the tube one does not have to understand the intricacies of tube design any more than one has to understand the particulars of magnetic relay and contactor design when he applies these devices. In order to understand industrial electronic tube circuits, there are two basic concepts which are very helpful.

A vacuum tube can be considered as a variable resistor with the grid element connection being the slider on the resistor. A change in the voltage between the grid and cathode elements is equivalent to changing the position of the slider. This changes the tube plate current or the current through the variable resistor and the (plate) resistor in series with the tube. The change in voltage across the plate resistor is the output voltage of the tube. This is usually used to control a second tube, etc.

The other concept is that a thyratron tube is nothing more than a very fast on-off switch. The control grid is used to turn the tube on at the proper time. When used in a rectifier on a 60-cycle supply line, the thyratron is a switch which operates 60 times a second and is on for either a complete half cycle or a fraction thereof.

These two concepts and a properly drawn line diagram are all the essentials that one familiar with control line diagrams requires in order to understand the majority of circuits used in industrial control equipment. This is true, of course, only where the designer has succeeded in making his circuit simple.

In regard to the comments on tube life, our company has sold thousands of electronic drives with both vacuum and gaseous-rectifier tubes. Rarely do we have complaints on tube life or on bad tubes. On one repetitive drive of which we have put thousands in the field over the past seven years, we have our own service man who reports practically all the troubles encountered with the drive. Over the past few years, there have been more troubles with the relay and contactor used than with the electronic equipment.

Lately there have been a number of magazine articles regarding tube life and the harmful effects of changing tube characteristics with aging. Most of these complaints have been voiced by the men associated with the use of tubes in computors, business machines, or military applications, where one equipment may employ as many as 18,000 tubes. With such a large number of components, they are very likely to have failures just because of the law of probability. In a circuit employing only a few tubes, and with the tube limitations correctly considered in design, electronic equipment can be made very dependable and successful as has been our experience.

Multiple Burners

IN OPEN HEARTH FURNACES

By H. T. WATTS
Chief Combustion Engineer
Southern District
Republic Steel Corp.
Gadsden, Ala.

. . . . paper presented before Birmingham, Ala. regional meeting of the American Iron and Steel Institute, September 26, 1951 . . . .

▲ FUEL burners on open hearth furnaces have engaged the casual interest of those concerned for many years. Recently, these have become decidedly more interesting to the open hearth supervision and others up and down the line of authority over the furnaces. This sudden up-surge of interest in an element usually considered devoid of possibilities may be attributed to the great demand for steel in our long-lasting wartime economy. The operators probably looked upon the possible improvement of the burner as a last resort in their quest of an extra ton of steel per furnace hour, after having followed every other such possibility to a conclusion.

It appears that study of burner design, followed by changes aimed at higher production rates on present furnaces, has been quite general over the country, and creditable improvement has been achieved in many instances. It is perhaps true that in designing and installing fuel burners in the past, many have been prone to proceed without full knowledge or adequate consideration of the duties the burner is required to perform or the many variables with which it may be confronted. Perhaps much more improvement will be made if, after diligent study, the real secret of this device, and the true principle governing its operation is learned. It may then cease to remain merely a lance used to deposit fuels at an advanced position in the furnace. Instead, it may become a well designed apparatus, able to perform any duties required of it.

The burner should be able to receive and process such fuels as are available, release from them all contained heat and deliver it to the furnace, and charge at any rate required in the operation without excessive damage to the furnace or its parts and without undue waste of fuels. It must produce a flame which will assist in proper distribution of this heat, giving to each area of the bath or charge the quantity of heat which it can gracefully receive and utilize, withholding from each area any heat which might cause damage to it. While so doing, the burner must be able to protect itself from the intense heat which it helps to produce, and to resist any actions which might reduce its effectiveness, either through abrasion or clogging of its critical nozzles or orifices.

These are the principal duties of the open hearth burner. Sometimes the burner performs them none too well. Perhaps it might more successfully meet its obligations were it not for the many variables which affect its operation.

WELL KNOWN VARIABLES

Any attempt to name all of these variables would be futile, but many of the factors which make difficult the design and operation of the burner are well known. These include: the changeable fuel requirement, variable with the progress of the heat and with the age of the furnace; the use of two or more fuels, singly or in combination, and the use of coke gas, whose successful application as a part-time substitute for fuel oil is sometimes considered quite difficult. One more variable may be of interest in this connection. This occurs during the annual period of natural gas shortage, particularly grievous during the winter at plants where natural gas is the principal fuel. In this period, the natural gas available for the open hearth is extremely variable and, in a single day, may run the gamut of hourly volumes, from straight natural gas to straight fuel oil and many intermediate ratios.

Combination burners became a necessity when the operators were first required to burn two or more fuels on an open hearth furnace. Arrangements were made to burn the fuels separately or in combination, using any desired proportions. The combination burner is a familiar type of multiple burner which has been in common use for many years. It is definitely related to type of fuel.

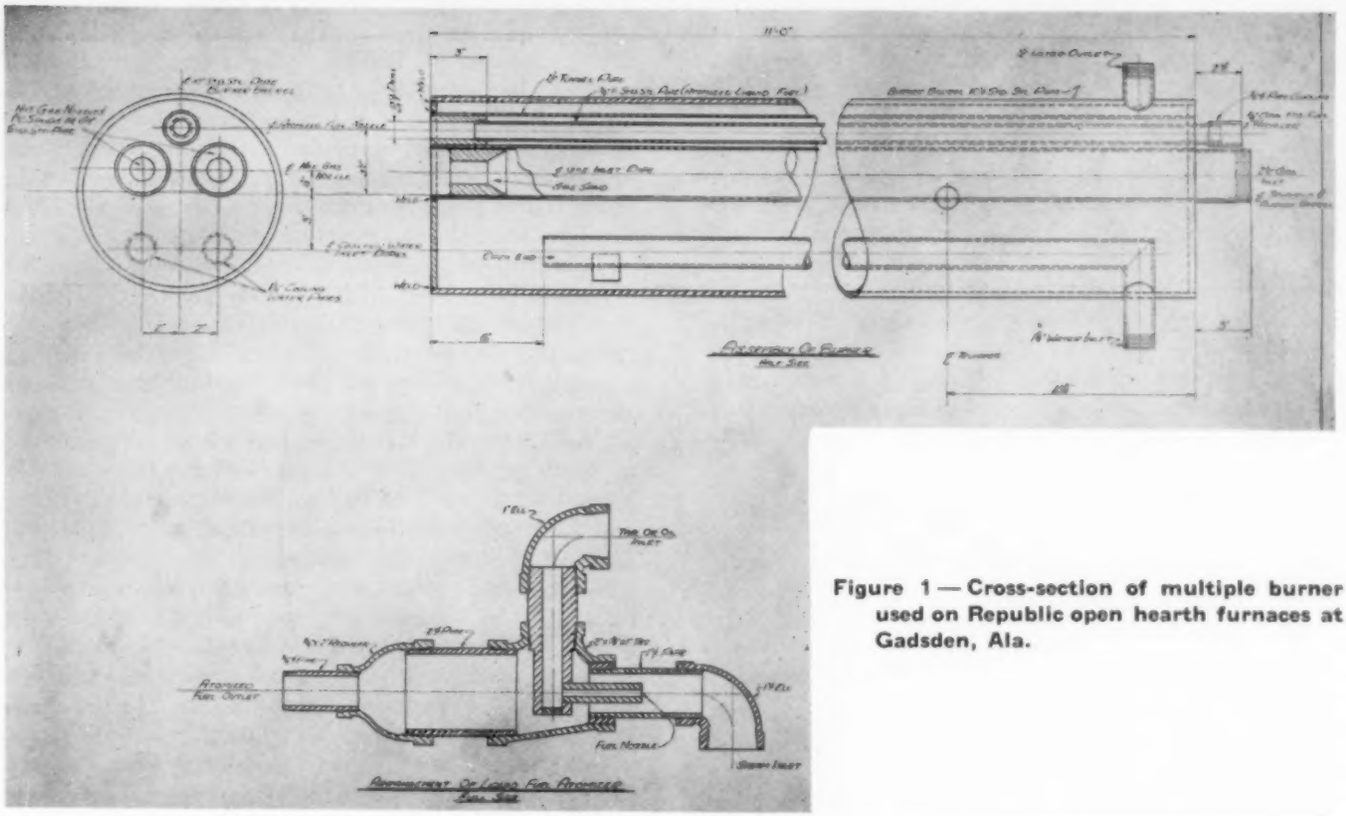


Figure 1 — Cross-section of multiple burner used on Republic open hearth furnaces at Gadsden, Ala.

There is another particular type which also bears the name, perhaps more properly. This is the burner in which the component elements are in duplicate or multiple, including gas nozzle, oil nozzle, atomizer or other part. So far as the type and number of fuels is concerned, it is identical with its single element predecessor from which it was adapted. It is usually related to the quantity of fuel used rather than the type of fuel. It was conceived, designed and installed against a backdrop of war when more steel was sorely needed and there was no steel with which to build facilities to produce it. This multiple burner was employed with the hope that the furnace could utilize a greatly increased fuel input during the early stages of the heat when scrap was being melted down, and that this would accelerate the operation and definitely decrease the time of heats, enabling presently installed furnaces to increase production.

Launching on this program, the operator was soon dissatisfied with efforts to push existing fuel burning facilities to the higher rates desired in the early hours of the heat. He determined to gain his end by the installation of a second burner on either end of the furnace, usually a duplicate of existing burners. By this means he was able to burn fuel at excessively high hourly rates for certain periods of the operation without apparent damage to the furnace in these periods. The result was a welcome increase in tons per furnace hour. In original installations, burners were placed in vertical line, one directly above the other. Someone found that considerably better operation was obtained with burners placed on a horizontal line, side by side. Complications were reduced when the two oil and two gas nozzles were compounded into a single burner having all elements in duplicate. The elements were placed side by side as in the case of the separate burners.

It was said that the operators were well pleased with the increase in tons per hour made possible by the double burner, but were somewhat dismayed that the fuel per ton did not decrease as expected. The hope for lower fuel consumption at the increased production rate was based on an old superstition that tons per hour and Btu per ton on a furnace are inversely proportional. Of course this proposition is only true when the average hourly rate at which fuel is used on each heat remains the same. Many furnaces operate day after day with the same average hourly fuel input, this rate being a compromise between the maximum possible flow through the burners, and the maximum capacity of the furnace to consume fuel without destroying itself. It was therefore not exactly unreasonable to expect a lower fuel consumption in connection with the increased tonnage, except that the success of the double burner was definitely predicated upon use of additional fuel during the melting down period.

A striking statement is recalled which was made by an operator of long standing. In effect, he was not concerned about Btu per ton, since this would take care of itself and remain satisfactorily low if he could manage to get steel into the ladle, plenty of it and quickly. He was obviously inhibited by limited fuel flow. He could not reduce the fuel per ton unless the tons per hour were increased, nor could he increase production without decreasing the fuel per ton. The double burner took the shackles off the operator, giving him more fuel with which to produce the extra tonnage. He could now produce more tons per hour without further taxing an already highly developed program of economy and efficiency.

It is understood that some plants showed a moderate reduction in fuel per ton along with the increase in tons per hour, indicating the effect of improved efficiency.

It is probable that some may have experienced an increase in fuel per ton. Generally, the development was effective in producing the steel at a faster rate, which was the original object of it.

In another instance, the multiple burner was used, not to increase the fuel input, but in an effort to improve the efficiency at existing hourly fuel flows. It was hoped that the division of the present gas stream into two or more smaller streams would so improve the nature of the flame, its temperature, radiating power and coverage of the charge that tons per hour and fuel per ton would both be improved. As a matter of fact, such results were obtained. The change in burner design referred to was made at the open hearth plant of the Republic Steel Corp. at Gadsden, Ala. Figure 1 shows

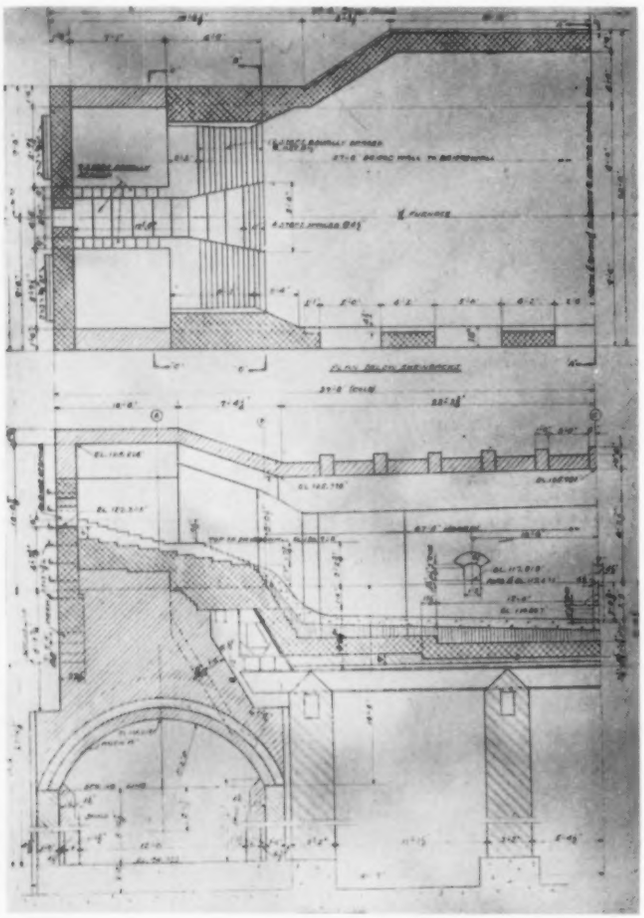


Figure 2 — Sections show furnace brickwork on Republic open hearth furnace No. 8 at Gadsden, Ala.

a drawing of the type of burner now in use on all of the open hearth furnaces.

VERSATILITY IN HANDLING FUELS

A novel feature of these furnaces is their ability to operate with straight fuel oil or straight natural gas or almost any combination of the two. Natural gas is the primary fuel, while fuel oil is the secondary.

Normally, these furnaces use straight natural gas for the melting down period. After the hot metal addition, a combination of fuel oil and natural gas in approximately equal amounts is used until the heat is finished. By the month, the fuel proportions consist of 25 to 30 per cent fuel oil and 70 to 75 per cent natural gas. In the seasonal period of gas curtailment, the natural gas ratios vary widely throughout the day. Under real winter conditions, no natural gas is available for the open hearth, and straight fuel oil is used on these furnaces until the gas supply is improved.

This shop now consists of eight furnaces in line, two of which were built soon after the acquisition of the plant by Republic in 1937. The six smaller furnaces have been remodeled several times for greater capacity, since their original installation as 60-ton furnaces many years ago. The old furnaces were fired with producer gas exclusively until natural gas became available in this area, at which time the latter became the sole fuel. Partial application of fuel oil for improved operation and for standby service was instituted about 1938.

The first natural gas application was with low pressure side burners. This was soon discarded and replaced by a method in which the gas was floated into the middle uptake at a point just below the floor line, where it met the hot air rising from what were formerly the gas checkers of the producer gas layout. Too rapid destruction of the furnace ends dictated the abandonment of this method, and the gas pipe was raised and inserted through the end wall at about the center of the water cooled port hood. Gas was released under this hood about midway of its length. Experimentation with slightly higher air pressure in the middle uptake, and with various natural gas pressures, while continuing with the hood, were not met with signal success. The first great improvement was made when, with some misgivings, we removed the port hood entirely and raised the gas pressure 30 psi, using a burner of the shot gun type, single barrel. This consisted simply of a long 2½-in. gas pipe shrouded by a larger concentric pipe, through which water was circulated. A restricting spud or bushing, which determined what gas pressure was to be required, was welded into the discharge end of the gas pipe. Burners of various lengths were used, but best results were obtained when the end of the burner reached to the forward face of the uptakes, about six feet from the shore line of the bath. The burner extended through the end wall into the furnace atmosphere, and had external means for changing its direction, either vertically or horizontally. The middle uptake was discontinued, leaving two uptakes on either end. These rose from single slag pockets but checker chambers remained in duplicate as before.

FOAM PROBLEM

With this construction, improvement was evident, but there remained a period in the heat, immediately after the big addition of hot metal, when a foam formed over the bath and caused hours of delay in effecting heat penetration through it to the unfinished steel below. Low pressure gas was used at this period, but this could not be kept off the roof. Combination high and low pressure jets were used simultaneously, the high to direct the flow of the low, but this failed to give sufficient luminosity to cut through the foam. Other steps were taken but nothing appeared to be satisfactory

until oil was introduced in combination with the natural gas at this crucial period. This satisfactorily solved the foam problem.

For this purpose, a ¾-in. standard oil pipe was added to the gas burner and located on the vertical center line just above the gas pipe. The conventional type of oil atomizer was employed using steam for this purpose. The 2½-in. gas pipe through the burner was continued, and a gas spud 1¼-in. inside diameter was used.

No changes were made in this burner until recently when, for the purpose of improving the efficiency, it was decided to burn the gas in multiple through two identical jets placed side by side, with but a single atomized oil jet between and slightly above the gas jets. This is also shown in Figure 1. The burner, previously mentioned, now had the appearance of a double-barreled shotgun.

We might call attention to some of the features but, in general, the drawing is self-explanatory. The atomized oil pipe is dry throughout its length except for the last three inches. Two water inlets are provided, each with a shut-off valve. In case one feed hose fails, its valve is closed while the other water inlet carries on. Water inlets remain inside the burner barrel and are not exposed to the intense radiation of the furnace. Nor do they present a problem in burner erection.

The liquid fuel atomizer used with this burner is shown on the drawing. This is of the type in which the emergent oil stream is flowing against the flow of steam when the two first meet. It is customary to change the diameter of bore on the oil nozzle to suit the season and its fuel oil requirements.

The furnace to which this burner is connected has a hearth area of 763 sq ft and normally taps heats of 200 tons. The total heating surface including checkers, and arches and walls of checker chambers is 23,300 sq ft on each end of the furnace. The uptake area is 82.04 sq ft, area over bridgewall 88.97 sq ft and area at end of hearth 97.58 sq ft. Taking the uptake area as unity, these three critical areas are in the ratios 1 to 1.085 to 1.190.

Each furnace is equipped with a force draft fan which overcomes the frictional resistance of flues and checkers and delivers the air free to the port of the furnace. Gases are removed by the natural draft of the stack. Furnace pressure is automatically controlled by a butterfly damper in the stack. Air-fuel ratio and reversal are both under what may be termed auto-manual control. In this the instrument gives the indication or alarm that adjustment in air flow or reversal of furnace should be made, and the operator actually performs the operation by hand.

EFFICIENCY

The rather drastic change in burner design from single gas nozzle to double gas nozzle construction appears to have effected a 10 per cent increase in tonnage and a like decrease in fuel. However, as is usually the case, other variables crept into the picture and may have been in part responsible for the improvement. A most heartening feature of the new burner operation is the definite reduction in the repairs to the front and end walls above the floor, and a corresponding reduction in the idle time required to make these repairs.

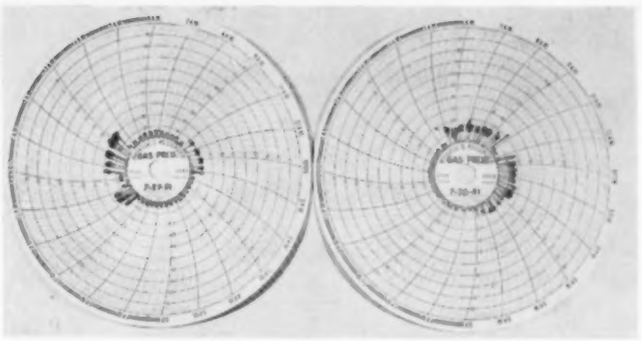


Figure 3 — Charts show variation in natural gas pressure at various stages of the heat.

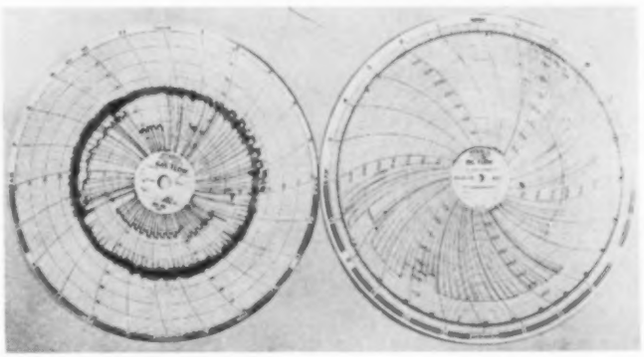


Figure 4 — Oil and gas flow meter charts from furnace No. 8 on August 11.

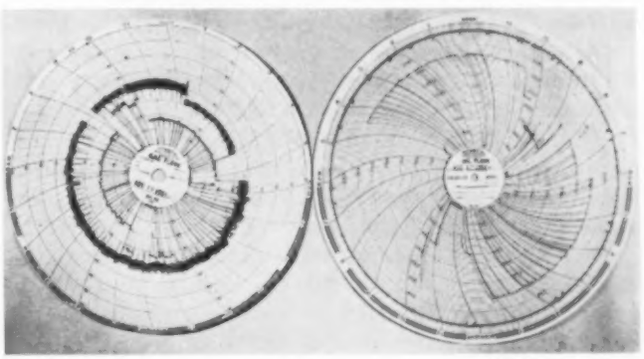


Figure 5 — Oil and gas flow meter charts from furnace No. 8 on August 12.

Figure 6 — Oil and gas flow meter charts from furnace No. 8 on August 14.

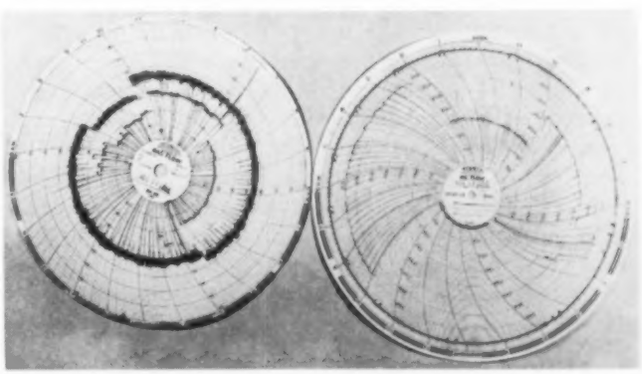


TABLE I

Temperatures and Pressures Observed on Combination Burner While in Operation on Natural Gas and Fuel Oil in Various Ratios on Open Hearth No. 8

Time	Details of fuel used				Nat gas pressure at burner, psi	Oil pressure at burner, psi	Oil temp at burner, F	Steam pressure at burner, psi	Steam temp at burner, F
	Nat gas cfhr	Fuel oil gphr	Total mill Btu per hr	Per cent oil					
Aug 1, 1951									
11:50 am	68,000	140	88,000	20	10.0	93	188	80	347
1:10 pm	33,000	272	73,000	55	3.8	110	198	....	350
1:40 pm	33,000	272	73,000	55	3.8	109	198	84	345
2:30 pm	36,000	272	76,000	52	4.0	114	194	86	358
3:00 pm	35,000	275	75,000	53	3.9	122	190	92	375
3:25 pm	36,000	285	77,000	53	4.0	119	189	87	375
3:55 pm	37,000	282	78,000	53	4.0	101	186	80	367
Aug 2, 1951									
10:25 am	78,000	....	78,000	....	14.0	....	....	....	....
11:05 am	79,000	....	79,000	....	15.0	....	....	....	....
11:20 am	78,000	150	100,000	22	14.5	116	176	110	387
11:50 am	80,000	150	102,000	22	15.2	111	180	106	375
1:15 pm	84,000	150	106,000	22	15.2	102	183	96	375
1:45 pm	84,000	....	84,000	....	15.0	....	....	....	....
2:10 pm	84,000	....	84,000	....	15.0	....	....	....	....
2:35 pm	33,000	270	72,000	54	3.6	123	182	99	372
2:55 pm	.....	270	39,000	100	....	122	182	99	365
3:25 pm	35,000	296	78,000	55	4.2	129	198	99	375
3:52 pm	.....	433	63,000	100	....	196	182	138	385

In changing from the single to the double nozzle design, the diameter of the gas nozzles remained the same as before, each at 1¼ in. This effectively doubled the gas nozzle area, reducing by half the velocity of the emergent stream of natural gas. Inasmuch as improvement accompanied the change, it would appear that the furnace had been operating under difficulties resulting from excessive gas pressure and gas velocity across the furnace. Perhaps in its quick trip to the outlet port it had insufficient time to leave an adequate fraction of its heat in the bath. As a result, the residual temperature was sufficiently high to destroy the brickwork in the furnace ends too rapidly and sufficiently high to hold the fuel consumption above the normal expectancy. The fact that the tonnage rate was increased and the fuel consumption decreased while the wall repairs above the floor were reduced coincident with the change in burners, makes one believe there may be truth in the above theory.

Another comparison may be significant. With the single 1¼-in. spud delivering all the gas through the old burner, we were operating most of the time at the critical velocity, in the viscous flow range. On the contrary, the new burner, with the increased spud areas, normally shows a velocity below the critical speed, remaining in the range of adiabatic or straight line flow. Possibly our improved conditions were in part due to use of gas velocities below the critical where confusion of flow lines is said to exist. The ordinary high pressure burner used for many years on heating furnaces is sensitive to this change in gas velocity. Perhaps it is not too fanciful to believe that the multiple burner for an open hearth furnace is in truth a high pressure burner. To this extent it would be a burner with potential energy in its fuel and steam pressures, which is converted into kinetic energy as these streams jet under the knuckle; while the jets engage the hot air also passing under the knuckle, drawing it into the fuel stream, driving it into the furnace and toward the bath, the two mixing all the while, finally becoming a homogeneous mixture ready for instant combustion as soon as it is spread and slowed down sufficiently.

In Figure 2, are shown brickwork cross sections of the furnace to which the burner in question is connected.

Actual natural gas pressures impressed upon the burner throughout the course of two 24-hour periods are shown on Figure 3. It is interesting to note the great difference in these pressures in the two periods of the heat: first, when natural gas only is being used; second, when a combination of the two is used to finish the heat.

Figures 4, 5 and 6 show pairs of oil and gas flow meter charts selected at random, and are exhibted here to show that the furnace operates through a part of its cycle on straight natural gas and no oil. There is no hard and fast rule that this condition must prevail during the melting down period, but it usually does.

On Table I is exhibited a tabulation of pressures and temperatures consecutively observed at the burner while in operation with oil and natural gas in various ratios.

FLEXIBILITY

This plant has an obvious advantage in its ability to operate with either of its two fuels applied singly, or with the two used in combination in any desired proportion. If one of the two fuels is scarce at the moment, this flexibility assures continued operation, provided the other fuel is readily available. The flexibility also permits selection of a fuel make-up conducive to low fuel cost per ton, when both fuels are readily available.

Casual observers frequently ask why these furnaces, with high roofs, obviously built for oil burning, can operate equally well with natural gas in very high

percentage. They are contrasted with many other generally identical furnaces which can burn gas in only small proportions and call oil the principal fuel. The fuel proportions are usually on the order of 70 per cent oil and 30 per cent gas, just the reverse of the ratios quoted for the Gadsden furnaces.

These furnaces are also in contrast with a few furnaces which burn natural or coke oven gas exclusively and do not use fuel oil. Furnaces in this category almost invariably employ steep arches, low knuckles and sometimes front and rear monkey walls, all of which give positive flow and direction to the air and gas as these float toward the bath. Low pressure gas is introduced through side burners. This arrangement is noted for low fuel consumption and rather high brickwork repair cost, but may be up to a ton per hour behind an otherwise identical furnace which uses high pressure fuels burned under a high flat roof.

The essential difference between the oil furnace and the low pressure gas furnace is the area of the vertically-set aperture through which the gases flow from the port end into the chamber of the bath. This section corresponds to that which forms the boundary between the movable and stationary parts of a tilting furnace.

In the high pressure, oil burning furnace, this area is large and wide open, of necessity to avoid destruction by the oil flame. In the low pressure gas burning furnace this area is small. By restriction of this aperture, sloping arches, bridgewalls, cross-flow gas burners and every other artifice, the gas and air entering the bath chamber are thoroughly mixed, and a sharp properly directed flame is produced. Flow through the aperture is motivated by stack draft.

LARGE AIR VOLUME

In the oil burning furnace where the port opening is large and unrestricted, the conditions are quite different. One wonders how an oil-steam jet, very small of cross section, firing through the center of a relatively large air passage into the furnace can possibly manage to properly contact, in its entirety, the large volume of slowly moving air. That it does so, is attested by analysis of gases passing down to the slag pockets, where complete combustion is indicated with very little additional air in evidence.

In this case, passage of hot air through the aperture into the furnace is motivated neither by forced draft fan nor by stack draft. It must be propelled by the momentum of the emergent stream of oil and steam from the burner, operating not over the entire area of the aperture, but in a circular area in line with the steam jet.

Into this cone of action, the steam is thought to draw the air required for combustion, and, in contact with the oil fuel, to drive it toward the bath where thorough mixing and instant combustion takes place. The jet has entrained almost the entire volume of air which was flowing slowly from the port toward the furnace. Truly, flow through the aperture was motivated by momentum of the high pressure jet from the burner.

On the Gadsden furnaces, all or a part of the energy in the emergent jet of steam is replaced by the energy in the jet of high pressure gas, and of course the action is identical. In the early stages of the heat when gas only is used for fuel, the gas at 12 to 14 psi is the sole agent used to drive the air into the furnace. In the latter stages when both oil and gas are used in equal fuel quantities, the driving action which occurs is contributed both by steam and by natural gas, the latter in lesser amount than before.

Previous mention was made of the difficulty encountered in burning coke gas in large quantities on a furnace designed primarily for oil firing. It is believed the difficulty rests in the low specific gravity of this gas and the low pressure at which it is ordinarily available at the open hearth. Both of these items reduce the momentum of the gas which we claim is the driving force which simulates a high pressure burner action within the end of the open hearth furnace. It is understood that some shops are preparing for large scale use of coke gas on open hearth furnaces at 15 psi, and perhaps the problem is destined to be solved.

PLAN TO ATTEND

AISE SPRING CONFERENCE

NETHERLAND PLAZA HOTEL CINCINNATI, OHIO

APRIL 28-29, 1952

JET TAPPER PRACTICE *at the Open Hearth*

By HAROLD WALKER
Superintendent Open Hearth
Republic Steel Corp.
Warren, Ohio

and

A. ROBERT ALMEIDA
Arthur D. Little, Inc.

. . . . condensed from paper presented at Annual Meeting of the National Safety Council, Chicago, Ill., October 9, 1951 . . . .

▲ IT is seldom indeed in open hearth experience to depart radically or suddenly from the conventional way of doing things. Changes in practice are gradual and take place almost without notice. Over a period of years we have introduced new tools and have become mechanized, as required by the demands of increased production.

Thirty years ago, we dropped the bar and sledge in favor of the oxygen lance to open up the tap holes of our furnaces; this year we are dropping the oxygen lance and substituting a directional explosive charge, the jet tapper. We are making a significant change after thirty years of apparent satisfaction with the conventional practice.

At the beginning of the development program it was hoped that we could reduce the hazards connected with tapping a furnace. Since then we have enjoyed not only a safer practice, but a practice that benefits the operation of the open hearth in many ways.

First, the jet tapper provides a good, clean, fast tap without heavy labor. The tap hole is opened from a remote position, and seldom do the slaggers have to use a tapping bar to knock out the hole. The task of the second helper has been made easier and safer.

Secondly, the uniform full stream flow of steel, right from the start, has given the melter the opportunity to tap and make the additions under the best conditions. Skull production is cut in half, the manganese drop is reduced and tap hole maintenance is improved.

Thirdly, the pouring practice is cleaner and safer. The running and leaking stoppers which were caused by plate skulls around the stopper have been reduced to a minimum. With this improvement we are enjoying better surface, better quality, and better working conditions.

DESCRIPTION

The jet tapper is a small, shaped explosive charge, designed specifically for the purpose of tapping the open hearth furnace. Two ounces of a relatively insensitive explosive are enclosed in a bakelite case, which is fixed in proper position in a hollow insulating body with walls one-half in. thick. This insulation is sufficient to prevent the charge from being destroyed by the heat of the tap hole, and sufficient to prevent the blasting cap from being detonated by the heat for a minimum of three minutes when in the tap hole of the open hearth.

The special high temperature electric blasting cap fits snugly into the well provided in the rear of the charge.

The bomb shaped insulating body, 3 in. in diam and 8 in. long, has a flat bottom to prevent rolling, and is easily fixed to a loading pole for proper positioning against the facing of the tap hole of the furnace. The loading pole is made of spiral wound cardboard tubing.

The hollowed shape of the explosive and the copper liner are responsible for the ability of the jet tapper to punch a hole through the frozen crust of the tap hole, with little sideward and rearward blast effect. This shaped charge will penetrate, under controlled test conditions, about seven in. of cold, mild steel. Yet in all our experience there has never been any evidence of damage to the tap hole structure; in fact, our tap hole maintenance has been reduced, and the tap holes are maintained straight as originally designed.

When the charge is detonated by the electric blasting cap, the high pressure developed by the explosion causes the copper liner to collapse progressively from its apex to the base, squeezing a jet of copper particles from the inner surface of the cone. These tiny particles, traveling at speeds up to 30,000 ft per sec possess tremendous energy and will penetrate any type of target. As the energy of individual particles is dissipated in penetrating the facing of the tap hole, succeeding particles continue to penetrate until all material of the jet is exhausted. This action takes place in a matter of microseconds. As we hear the explosion, we happily observe a full stream of steel pouring into the ladle.

The jet tapper helps in starting the furnace tapping.

RESULTS

The present design has been fixed for over a year, and nearly 2500 units have been fired to date. It is generally felt now that the occasional failures of the jet tapper to open the tap holes are attributed to irregularities in method of tap hole maintenance, or unusual conditions with respect to the particular heat, such as long charging delays which cause hard metal soaked holes.

As far as the operators are concerned, by that we refer to the second helpers, the opening of the tap hole with the jet tapper is an easier task than the corresponding use of the oxygen lance. It is a one-man operation, with full responsibility given to him. He handles the charge and has possession at all times of the mechanism by which the charge can be fired. There is no doubt that the jet tapper has promoted safety. Our operators respect this device and follow to the letter the standard operating procedures. Their cooperation and compliance has been gained by the fact that the jet tapper does a good job for them. From the point of view of the melters, it permits better control of the heat at tap time.

Let us take a look at the operating results from the Warren shop.

At Warren, our production consists by and large of low carbon rim grades, with a scattering of aluminum killed and low carbon silicon grades. With this schedule it is found necessary to plug the tap holes tightly, perhaps more so than at other shops. The following practice is followed to close the hole; after tap, the hole is first chilled off until clean and dry, then filled with double burnt dolomite by the second helper from the rear of the furnace, and finally faced off by the first helper, again with double burnt dolomite. Raw dolomite is never used.

With the jet tapper practice we generally gain a full stream flow of steel as soon as the hole is opened. Thus, a tapping bar is not required to clear the hole. The resultant tap, about one to two minutes faster than the oxygen lanced tap, is steady and uniform. The tap hole itself is generally free of ridges, and is maintained in alignment, in contrast to our former oxygen lanced holes which tended to drift to one side.

This uniform tapping of the heat permits our melters to tap when ready; they do not have to wait for a little more temperature to protect themselves against a poor tap. Where we have to watch surface quality so critically, this is an important factor.

It has also been observed that the manganese drop from first to last ingot during pouring has been reduced. Generally our manganese losses are fairly high, since we work with highly oxidizing slags to promote good rimming. The frequency of a four point or less manganese drop has been increased from 50 to 60 per cent. This again is of importance to quality and yield.

The most tangible results of the faster tap are given by our skull production. By eliminating the dribbling start of the tap, the jet tapper reduces both the number and weight of skulls.

With reference to the heavy skulls on the low carbon rim grades, it may be noted that the frequency of heavy skulls has been reduced from 13.6 per cent to 7.5 per cent. Note also that 85 per cent of the successfully jet tapped heats have not had any skull. Putting this on a weight basis by assuming 4000 lb as the weight of "bottom" skull and 5000 lb as the weight of "1 ft or over" skulls, it is found that 203 jet tapped heats produced an average of 310 lb of skull per heat compared to 589 lb per heat for 323 oxygen lanced heats. This represents a reduction in skull of 47 per cent. Actually, the number of scrap skulls has been correspondingly reduced so that on a weight basis the total skull has been cut by at least 50 per cent. These results are certainly significant and represent important savings.

At Buffalo, the jet tapper was introduced late in December and was quickly adopted by the shop. At the time of the preparation of this paper, results were available on the firing of some 350 jet tappers. These results were considered premature, although they paralleled closely the Warren experience. In fact, the skull savings were even greater, and the benefits of more important significance in that shop whose production is made up of higher carbon killed grades.

An important advantage to jet tapping, noticed immediately at Buffalo, came from the pouring platform. The operation of the ladle stoppers became much more uniform, and the frequency of leaking and running stoppers was substantially reduced. This is attributed to the fact that skulls at the stopper well of the ladle have been minimized. On the basis of actual ingot count, the use of the jet tapper in January cut the number of leaking and running stops by more than 50 per cent.

RECENT LUBRICATING PROBLEMS

at

SPARROWS POINT

By A. E. CICHELLI
Lubricating Engineer
Bethlehem Steel Co.
Sparrows Point, Md.

.... many lubricating problems can be solved by improving the design so that the lubricant will do the job it is supposed to do....

▲ JUST so long as two materials are in contact and move with respect to each other, a problem in lubrication exists. To save himself untold grief and delays later on, the lubricating engineer should do everything possible to scrutinize and approve drawings of new equipment, and in so doing recommend any changes, whether based on experience or not, that would insure adequate lubrication and minimum wear on moving parts. Sometimes, even with those precautions, new factors arise creating additional problems which must be sought out by the lubricating engineer, studied and eventually corrected.

Many may ask how can this be accomplished? How can trouble spots be brought to light in large complex plants, especially if they are not of major importance? Much of the answer to these questions is found in the organization that exists and the place the lubricating engineer holds with respect to those about him. By being part of the general mechanical department, not only does the lubricating engineer exercise the proper influence, but he also has access to much of the operational and maintenance data in the entire plant. For example, daily delay reports are studied for troublesome units and looked into when the occasion warrants. At the end of each monthly period, composite delay reports are made up and studied for repetitious items. This is the formal approach and by far the least informative. Frequent visits to master mechanics and their subordinates are more productive than the delay report. Their continued complaints generally have something behind them and should never be left unheeded.

Finally, and of course, the best system of all is the personal contact method. On-the-job examinations of a problem by the lubricating engineer—and that does not mean just on repair day—is certainly the most self-satisfying foolproof, and fruitful.

Once a definite problem has been established as one in which the lubricating engineer has a stake, then he must call first on experience and plant records, and if neither are available, he should employ well-established principles in arriving at a solution to the problem. He should under no circumstances be swayed by departmental preferences.

The remainder of this paper deals with specific problems in which lubrication of machinery was involved, and in which some interesting results were obtained.

160-IN. PLATE MILL TILT TABLE LINE SHAFT DRIVE

An illustration of changing a design to effect improved lubrication which is in a sense unique, is one which occurred in the 160-in. plate mill. In this mill, there are tilting tables at the front and back of the mill which consist of rolls driven by a lineshaft and mitre gears. Their original design called for a splash lubrication of the gears and grease lubrication on the bearings. The gears were enclosed in a housing consisting of sections bolted together along the entire length of the table. Up near the mill, on each side, were short roll sections, where the gear case came under the direct impingement of hydraulic water from the sprays used on the mill. Even though the covers were made to minimize the entry of water and scale, it was found impossible to prevent their entry into the drives. There were openings in the gear case of the short roll sections that were impossible to close entirely, and as a result, water and scale entered as the table tilted up and down, causing the gears to churn oil and water into an emulsion. The incident of bearing failure was very high, not

only because water and scale kept getting into the bearing area, but also because of corrosion that set in on the bearing seats themselves. Often the drive was down during the week for bearing repairs. Premature failure of the mitre gears was inevitable in view of the resulting mis-alignment. It was paramount that this problem had to be licked, and it was eventually solved by reverting to a practice now considered primitive. Reference to Figure 1 shows that by cutting holes in the bottom of the gear case under each gear, and access holes above the mitre gears for lubricant replenishment, it was possible to completely eliminate this severe problem. Oil was replaced by an open gear compound introduced into the holes referred to. Bearing failure now is rare except where damage occurs to the grease feed lines. As for the gear themselves, they enjoy a greatly extended life, a fact traceable to the bearings holding their alignment. This table has operated satisfactorily for over ten years with this changed design. However, it is now being replaced by another table because of corrosion to the structural members. On Figure 2, you will notice that the new 160-in. table will incorporate the open gear design throughout and, in addition, a deflector plate will be welded to the table girder to keep water, salt and scale away from the structural members under the rolls.

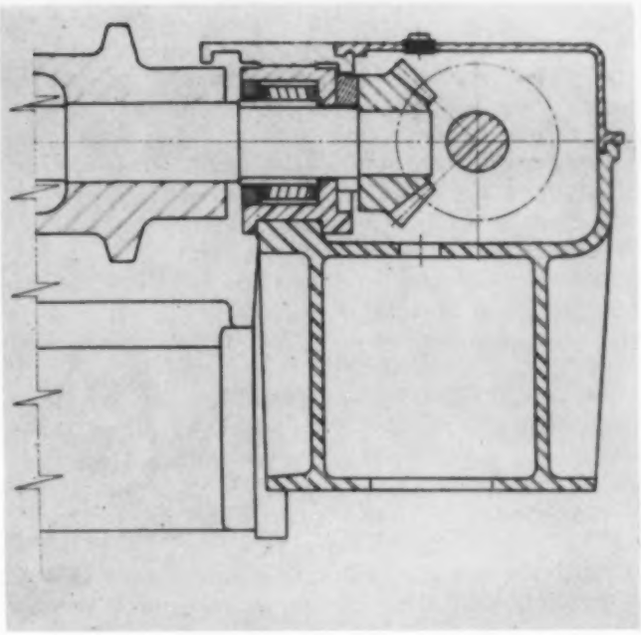
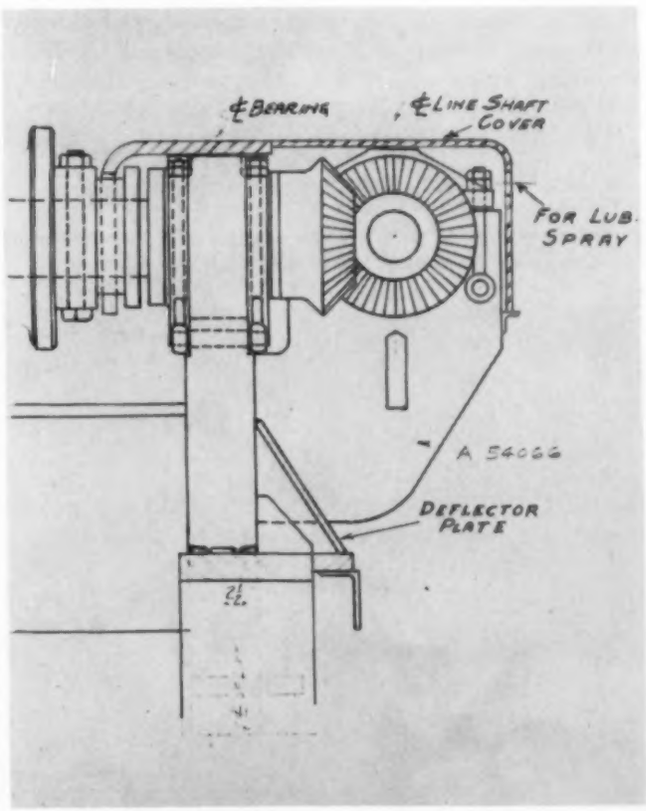


Figure 1.— Relatively minor design changes eliminated lubrication troubles on this line shaft drive.

COMPOSITION BEARINGS

The use of phenolic and fabric bearings at Sparrows Point is certainly not new at this time. Most of the development work was done between 1930 and 1944. However, some of this work we consider interesting enough to pass along. At Sparrows Point there are three plate mills, a 60-in. universal, a 110-in., and a 160-in. mill, all of which now use composition bearings. However at first, these bearings were tried on the 60-in. universal mill where the thrust loads are considerably heavier. Furthermore, the first bearings were tried on the top rolls where the thrust load was less than, say, on the bottom, inasmuch as the top roll was designed to float. The very first test runs showed life durations of three weeks to a month for the shell and two weeks for the thrust. Bearing material was lignum vitae and provisions were of course made to prevent the entry of scale into the bearings. This performance was not considered satisfactory, although sufficiently encouraging to warrant their trial on the bottom rolls as well. Next, composition bearings using heavy belting material instead of lignum vitae, were employed and the results were more encouraging, as two months life was obtained. But here again, the thrust lasted only two weeks. Everyone generally agreed, that if some improvement could be made to the thrust, the life of the bearing would be enhanced. It was then decided that the insertion of a high lead bronze segment in the center of the thrust collar would materially support the composition segments on each side and should have a beneficial effect on the bearings themselves. Figure 3 illustrates what was done. As you will notice, a bronze section is fitted into the bottom. The thrust collars of course are separate from the bearings and are rolled in place and locked in on each end by keepers that are dovetailed onto the shell. Results from this improved thrust collar which, incidentally, is subjected to water lubrication only except during shutdowns when all the bearings and collars are covered with oil, exceeded our fondest hopes. The life of the thrust collar itself was increased tenfold and the bearing, as a result of the improved thrust collar, lasted six months instead of two. Due to the fine results on these mills and some of our bar mills, and in view of the present pending tin shortage, study is under

Figure 2 — The open gear design is used in the new table.



way to determine what other applications of this type bearing can be made.

There are several other points in connection with the use of these bearings which have been repeated elsewhere, perhaps many times, but in order to cover the subject completely, it would be well to mention them briefly here. For example, it was found that when salt water was used on the necks, a high corrosive condition developed which reduced bearing and roll-neck performances considerably, especially when the water was hot. Speaking of water, it is generally known that the water temperature cannot be allowed to go too high, because of the rapid drop in its viscosity above 105 F. We found, like most everyone else, that the use of these bearings resulted in 20 to 40 per cent saving in power, along with appreciable savings in lubricant costs. In assembling our bearings, we attempt to maintain a $\frac{1}{32}$-in. clearance between the inside diam of the bearing and the outside diam of the necks.

Furthermore, composition bearings are not used on the middle roll of our three-high plate mills because operators make this roll too tight to permit a stream of water to enter the bearing.

NO. 1 ROD MILL GEARS

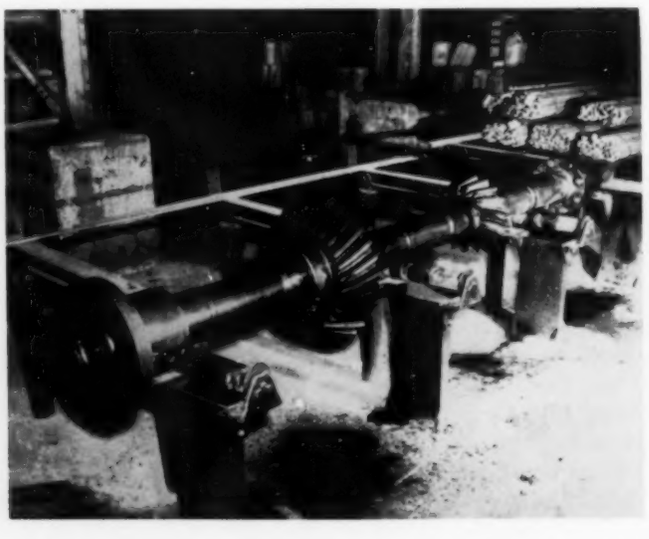
Our No. 1 rod mill supplies an example of the effect on the driving parts caused by changing the output of a machine. Its former design called for rolling two strands of rod and since 1929, the roughing drive was adequately lubricated using a straight 560 second mineral oil. (It was originally an open drive but enclosed during that year.) Initially, when the mill was started up, the pinion and drive gears, SAE 1040 steel and spiral-bevelled, pitted immediately after going into service. Upon wearing in, however, the pitting ceased and the gear teeth retained their strength and shape for the duration of the two-strand operation. In 1946, it was decided to increase the output of this mill by three-stranding which meant that the load on the drives would be nearly 50 per cent greater than before.

Upon three-stranding, within a very short period of time, the driving spiral-beveled pinions on No. 0, No. 1 and No. 2 stands began to wear badly and to pit and eventually lose portions of their teeth. Figure 4 shows a badly worn set of pinion gears for this mill. It became immediately evident that over-loading had taken place and there was question if a change of oil was going to solve this problem. No. 2 stand was the one most affected, inasmuch as a 40 per cent reduction was being taken on that stand. The wear occurred in the following sequence: pitting started at once, developing into spalled areas, followed by mild, then advanced galling and eventually, tooth breakage.

It was concluded that inasmuch as pitting began immediately, the fault was to be found mainly in the metallurgy of the steel in the pinions. However, it took two sets of pinions and an oil change, before a change in the metallurgy was actually made. A new oil, 760 seconds at 100 F, with lead naphthenate additive, was substituted in an effort to stave off the inevitable. It was felt by many, after the oil was put into service, that a slight improvement had taken place and that the pitting was retarded. However, this is not an established fact, inasmuch as soon thereafter a new set of SAE 4620 case-hardened steel was installed in place of the 1040 carbon steel. Up to this time, the SAE 1040 pinion gears continued to wear and break, even with the EP oil. Figure 5 shows these case-hardened pinions that were put into service in December, 1948. You will observe that the surfaces of these pinions, for the most part, are smooth and devoid of pitting or any signs of wear. The lead naphthenate type oil is still used and is probably the safest under present conditions; even it is a legitimate question if, with the case-hardened pinions, it would not be possible to revert to the straight mineral oil. You will observe pitting on the driving gears on the pinions beyond No. 2 stand. These gears and pinions are not case-hardened, being made of SAE 1040 steel. Their appearance is about the same as it was two or three years ago. While we are on the subject, it is well to point out that in a spiral-bevelled gear unit, and especially those on this mill, it is very important to make periodic examinations of its alignment, including an examination at the pitch line of each gear. It is

Figure 3 — A high lead bronze segment in the center of the collar had a beneficial effect on the bearing.

Figure 4 — Gears shown are badly worn due to overloading.



obvious that any mis-alignment will cause a large backlash at one point on the gear and binding at the other end. It is extremely important to align the gears so that backlash along the length of the tooth shank is kept as uniform as possible. Expansion effects on the lineshaft have a bearing on the alignment of the gears as well, and provisions must be taken to allow for it, or binding will take place, causing excessive wear.

HOT STRIP BEARINGS

Another interesting problem confronted us several years back, in our 56-in. hot strip mill. After eight years of operation, we found ourselves with an epidemic of wiped back-up roll bearings with no obvious explanation. The mill is a 10-stand mill having 30-in. diameter back-up roll necks, and a delivery speed of 1800 fpm. Its principal orders were for 0.076 in. prior to 1945, but heavy orders for drumstock, or 0.047 in. material, increased the load on the bearings and precipitated a series of breakdowns and delays from wiped bearings. Factors which came under study to determine the cause were such as welded necks, where the weld metal expanded at a different rate than the parent metal; babbitt analysis; condition of the oil, etc. In short, just about everything but the flow of oil was suspected. For one thing, the oil system was so designed that the four bearings from each stand drained through a common pipe, and although oilers made hourly checks on the temperature and the appearance of the oil in the sight flow, we were unable to learn anything thereby. It was not until individual sight flows were installed, which revealed that bearing oil flows at times ceased altogether, that we traced the cause of our troubles.

In Figure 6, is a section showing the oil feed arrangement at the bottom of these bearings. You will observe that the oil has to lift a spring-loaded ball check before entering. The check has a twofold purpose. First, it serves to hold the steel ball central over the oil orifice; the other function is to contain the oil in the bearing when it is taken out of the mill. Now the setting of the bronze leaf spring, used as a tension device, depends not

TABLE I

BACK UP ROLL FLOW TESTS—
HOT STRIP 30-IN. DIAM BEARINGS

(Oil Inlet Temperature—100 F)

Stationary

Size of orifice	Psi inlet pressure	Gpm with spring	Gpm without spring
No orifice (Standard Nipple)	8	3.44	6.66
	10	4.76	8.34
	12	6.12	10.70
	15	.....	.....
17/32-in. x 8-in. long	8	3.16	5.76
	10	4.12	6.98
	12	6.50	8.34
	15	8.10	.....
9/16-in. x 8-in. long	8	2.15	6.13
	10	2.88	8.10
	12	5.46	9.37
	15	7.32	.....

While running with springs using standard 1-in. Pipe inlet at 12 pis

Turn	8-4	4-12	12-8
West bearings	7.23 gpm	7.52 gpm	6.23 gpm
East bearings	7.59 gpm	7.84 gpm	6.46 gpm

While running without springs using 8-in. long orifices at 12 psi

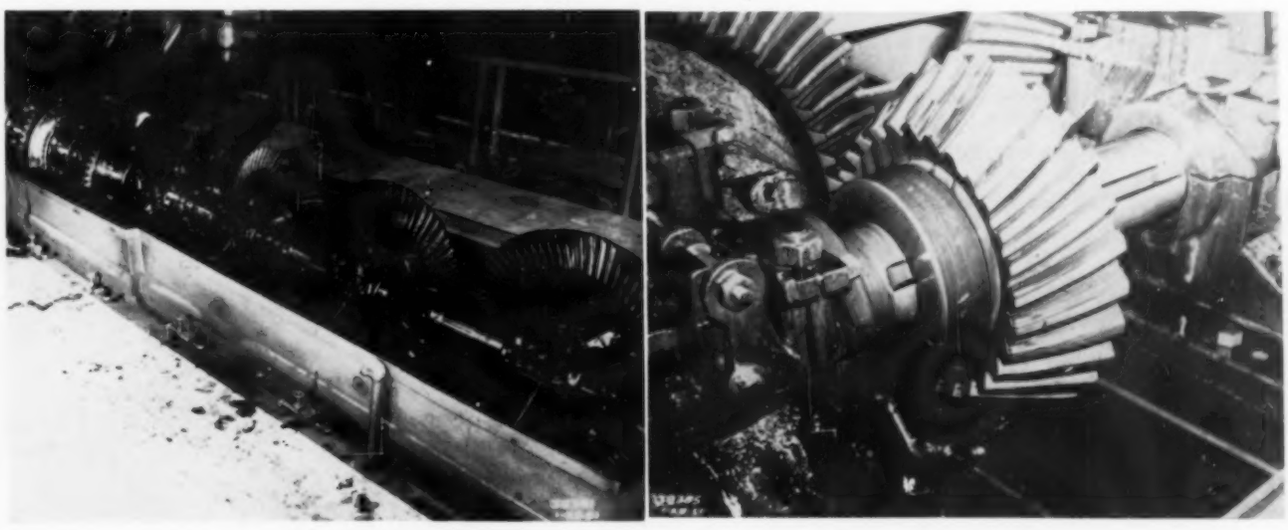
Top west—9/16-in. orifice	6.83 gpm	7.51 gpm	7.60 gpm
Bottom west—17/32-in. orifice	5.70 gpm	5.47 gpm	5.91 gpm
Bottom west—9/16-in. orifice	5.95 gpm	5.97 gpm	5.98 gpm

While running without springs using 1-in. straight through pipe

Bottom west	6.38 gpm	6.59 gpm	6.47 gpm

Note:
Pressure required to lift spring—4 psi.
Pressure required to lift ball alone—3/4 psi.

Figure 5 — Substitution of case hardened pinions eliminated wear and pitting. On left is overall view. Right view detail shows practically no wear.



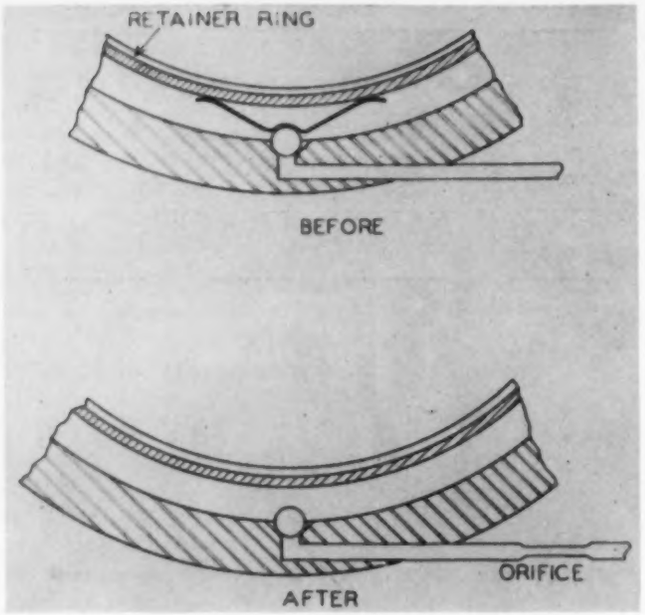


Figure 6 — Oil feed arrangement on backup roll bearings.

only on the material it is made of, but also on the degree of angularity given the spring by the repairmen. Realizing that, we investigated and found that the spring could actually be set so it would shift its position and thus hold the ball down against the oil port. With this discovery, we hastened to examine all spring leaves as quickly as we could, and much to our dismay learned from their appearance that some did shift to reduce the oil flow.

Not long after that, of course, we got out of our difficulties, but not until we conducted a series of flow tests on both stationary and moving hot and cold-mill backup rolls.

On Table I, we have listed some sample readings obtained during our flow tests on hot-mill bearings. The first runs were made on a stationary roll, readings being taken of the inlet pressure along with the flow both with and without the springs over the steel ball. Considerably larger quantities of oil passed through the bearing with the spring removed, and it was found necessary to establish the correct orifice size that would insure the correct amount of oil for each bearing. Once enough flow tests were made on stationary bearings so that our readings could be duplicated, it was decided to conduct similar tests on our No. 9 mill stand. Consequently this stand was equipped with flow meters and pressure gages for each bearing, and, as you will observe from the lower half of this table, flows of approximately 7 gpm could be obtained on both top and bottom bearings, a figure which was considered adequate at the conclusion of our stationary tests. The conclusions we arrived at from these tests were to install limiting orifices ($\frac{9}{16} \times 8$ in. long) between the strainer and the top-roll bearing and a straight through 1 in. pipe for the bottom bearings. It was found that installing an orifice on the bottom bearing reduced the flow too much.

This can be explained by the fact that when a bearing is in the mill and rolls separate, there is increased resistance to oil passage on the bottom bearing and decreased resistance on the top bearing. Of course, all our bearings have had their leaf springs removed and although the ball is left in the bearing and given more freedom of movement, there is no possibility of its blocking any oil passage.

One exception to this practice has arisen and that occurs in our fourth stand of the 56-in. cold sheet mill where today large tonnages of tin plate are rolled. Here it was found necessary to remove the orifice from the top bearing and to relieve the off-pressure side of all bearings to permit increased oil flow through them. This mill has 33 in. necks and a delivery speed of 3000 fpm with maximum screw pressures of 3,200,000 lb per screw.

Extensive tests on this bearing were also made to determine ways and means to pass more oil through it without reducing oil viscosity. The ball was removed altogether, as were the top discharge checks. However, it was found that despite these changes the limiting factors were speed, load on the bearings, and the path the oil has to take to go through the bearing.

Theoretically, heavy oil is desirable at low speeds

TABLE II

BACK UP ROLL FLOW TESTS—

COLD STRIP 33-IN. DIAM ROLL NECK

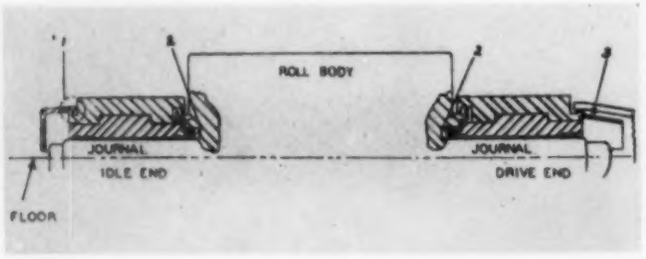
Bottom roll (Undercut)

Speed, fpm	No ball flow, gpm	With ball, gpm	Pressure set at threading speed, psi	Pressure reached during rolling, psi	Temperature, F	
					Oil, In	Oil, Out
Idle—200	7.71	6.19	15	23	100	116
1450	5.29	3.24	15	23½	100	118
1600	5.77	3.37	15	24	100	120
2500	5.24	3.79	15	24½	100	140
2600	5.27	3.80	15	25	100	143
2700	5.28	4.08	15	25½	100	146
2800	5.68	4.05	15	26	100	148

Top roll (Undercut)

Idle—200	5.46	4.87	15	13	100	112
1200	....	5.28	15	13	100	115
1350	....	5.50	15	13	100	122
1400	....	5.74	15	13	100	128
1525	5.49	5.00	15	13	100	140
2150	6.50	5.51	15	13	100	140
2200	6.50	5.22	15	13	100	140
2600	5.98	5.47	15	13	100	148
2700	6.00	4.90	15	13	100	148
2800	....	5.95	15	13	100	148

Figure 7 — Sketch shows a complete roll and bearing assembly.



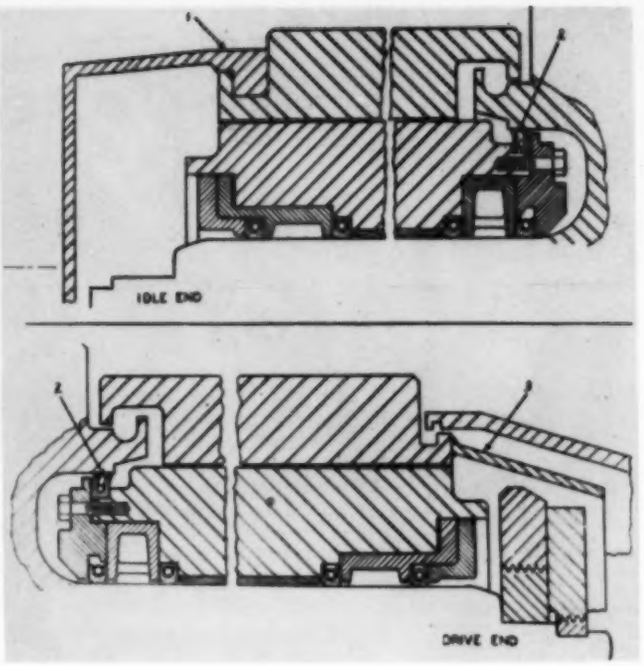


Figure 8 — Seal details on the backup roll bearing are shown in these sketches.

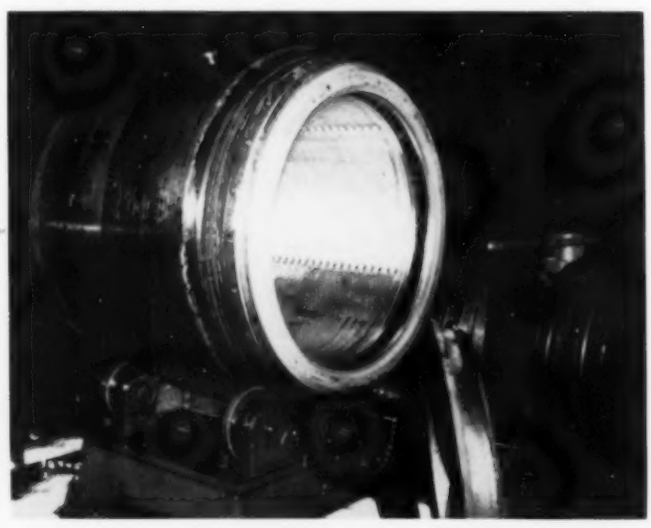
and high load, while light oil is desirable at high speeds. So it is felt that heavy oils are more desirable and means should be provided for their use. Further, oil consumption rises with decrease in oil viscosity.

Table II illustrates the flow of oil under various conditions and emphasizes the small amount passing through these bearings.

HOT STRIP SEALS

Our hot strip mills presented us with another annoying problem that we like to believe has been solved. As everyone knows, water and scale entry into back-up roll oil systems is very serious and high maintenance costs and mill delays are often traceable to this condition.

Figure 9 — Illustration shows a 33-in. bearing.



A number of seal designs were studied and some attempted over a span of 10 years, but none proved any better than the simple practice of holding clearances and tolerances correctly on both inside and the outside seals. By doing that, water percentages could then be maintained between 3-5 per cent, an improvement over the quantities that entered the system years before. So despite the improvement we felt that even this expedient was far from the answer.

One step in furthering our study of this problem was to chromium plate the bronze seal rings. In so doing, seal life was increased six-fold, but unfortunately, this did not reduce the water content as we had hoped.

The next step was to study circumferential expansion of the bronze seal and so establish clearances that as the temperatures rose the seal ends would just come together and no more, for if the circumferential expansion was too great, the seal ends would butt causing the seal to leave the neck and slip, allowing oil to escape underneath. End clearances of 0.035 in. were established for 30 in. necks and 0.040 in. for 33 in. necks, along with side clearances of 0.005 in. for the inside seal and 0.008 in. for the outside seal. This practice was in the right direction but the overall problem still remained to be solved.

Eventually, we learned by trial and error that considerable water was entering the outside end of the bearing. Bear in mind, we have individual sight flows and water can be detected through them. It is understood, also, that water and scale only enter bottom bearings and all changes discussed therefore apply to these bearings only. For years it had been assumed that water entered the bearings at the roll body, and all attention was focused in that direction. Slingers were built in, all possible openings in the bearing assembly narrowed down, composition seals installed; yet, despite apparent improvements, none of them helped effectively.

It was some time until it was suspected that water might be entering at the extremities of the bearings, and that it would only be necessary to install water deflectors on the thrust side and re-design the chuck assembly on the work side to diminish water entry. Almost immediately upon making these alterations, our water consumption dropped to 1 per cent and under; seals lasted longer; the use of centrifuges was nearly eliminated; the number of wiped bearings was reduced to nil, and our oil consumption was decreased by over 30 per cent. We now average about 700 gal per week for each hot strip mill.

Figure 7 illustrates how we solved our problem so that today it is a rarity to reach 1½ per cent water in our systems, a condition which has become commonplace for almost two years now. A complete roll-and-bearing assembly is shown schematically in Figure 7, whereas Figure 8 shows bearing and seal details.

We realize that 700 gal per week is far from perfect and we are even now planning to do something about the roll-body end of the bearing.

Figure 8 shows how we propose to go about it. In fact, several stands have been equipped and in operation for several months. You will observe that water and scale can find their way between the roll neck and

the bearing chuck, after which nothing prevents them from reaching the outside brass seal. An extruded U-shaped neoprene material located outside of the brass seals, turned outward and held in place by means of a garter spring, serves to prevent foreign matter from entering and fouling the seals, and to date their performance has been very gratifying. By means of this extra seal, dirt and scale seem to be effectively kept away from the existing seals.

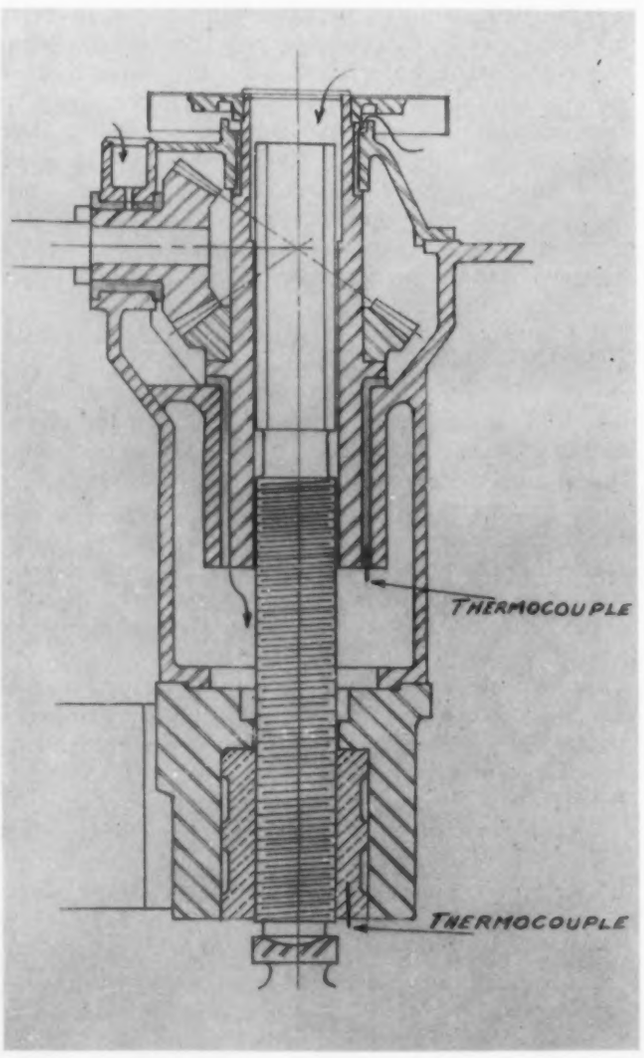
Figure 9 shows a 33-in. bearing alongside of which is a retainer and the new neoprene seal.

46-IN. BLOOMING MILL SCREWS

As has been common with most blooming mills today, a heavier rolling schedule on our 46-in. bloomer gave us much cause for worry. For a long time compounded cylinder oil lubricated the screws adequately, while black oil was satisfactory on the bevel-gear drive for these screws.

However, increasing rolling schedules, calling for wide slabs, forced the 46-in. bloomer to roll such sections as 4 × 46 in. from 26 × 50 in. ingots, thus requiring considerable up and down movement on the part of the screws. Ninety per cent of the output on this mill is slabs. The screw diameter is 12 in. having a 2 in. pitch and it has an upward speed of 14.2 fpm and a downspeed of 8.8 fpm.

Figure 10 — Section through screw of 46-in. blooming mill.



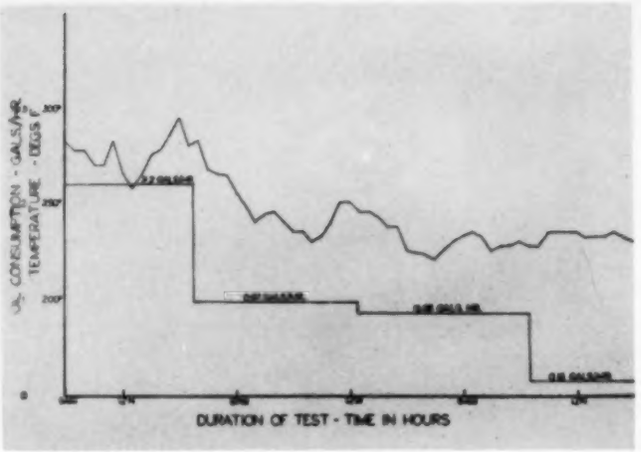


Figure 11 — Curve gives oil consumption data on screw-down lubrication test on 46-in. blooming mill.

Our screws have been mostly high-carbon, SAE 1060, normalized, and the nuts are made of 90 per cent Cu and 10 per cent Sn. We average two, but have had as many as three runs on one pair of screws, and a maximum of a little over 2,000,000 tons. This is far from a record by some standards, but considering our type of rolling it measures up satisfactorily.

On Figure 10, you will observe a section through one of our 46-in. mill screws, illustrating the manner in which its various parts are lubricated.

Recently, we decided to try to do something about oil consumption which ran about 8 gal per screw per turn. The thermocouples were attached to one sleeve bushing, as well as to the nuts themselves, to enable us to record the temperatures during the test runs. Cylinder oil with 7 per cent acidless tallow, which had been in service up until this test, was tried first. Our nut temperatures ran about 300 F, with an oil consumption of about 8 gal per turn per screw. Room temperature during this and the remaining runs of this experiment was around 90 F. Lead naphthenate products of varying viscosities, from 120 SSU at 210 F to 300 SSU at 210 F, were tested afterwards with some very interesting results. For one, there was an immediate reduction in nut temperature of about 25 degrees. Figure 1 has been made giving a graphic description of this test and showing the average temperatures recorded and the oil consumption.

Furthermore, it was also learned that consumption of lead naphthenate products dropped to a low of ¾ to 1 gal per screw per turn, with no increase in temperature and with no apparent harmful effect. In fact, it was proved without a doubt that an increase in oil flow actually causes a rise in temperature. Surprising though this seems at first glance, at the time these results were obtained, the screws and nuts were new and the fit neat, undoubtedly accounting for the high temperature accompanying high oil flow. In fact, the operators complained that they could not hold their mill because the screws would spring back on them.

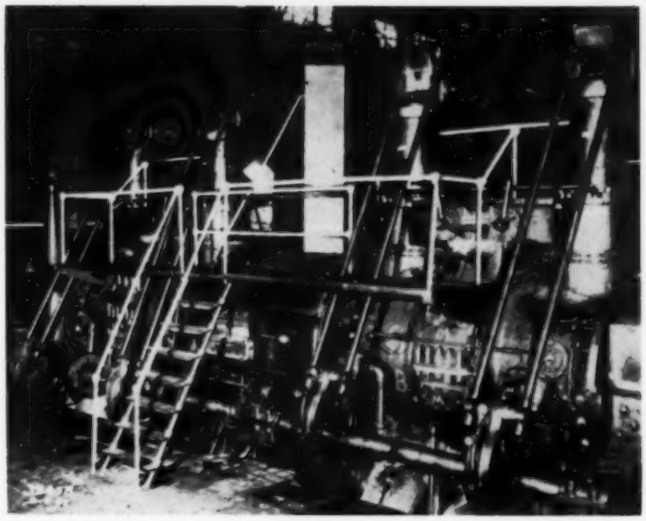


Figure 12 — There were 64 points to be grease lubricated on this engine.

GAS ENGINE GREASE SYSTEMS

Measured grease systems have been installed on almost every conceivable piece of machinery at Sparrows Point. Wherever accessibility or consumption is a problem, a centralized system is installed if there is half a chance of its staying in place.

Mill-table rolls originally designed for oil lubrication have been changed over to grease and put on systems. Open hearth cranes and others, the shaft bearings of which were designed for waste pack lubrication, have been converted to bronze or babbitt bearings and then lubricated through centralized systems.

Application of the centralized system to gas engines is one of our most recent steps in this general trend.

Everyone familiar with large blast furnace gas engines is fully aware of the hazards attending their lubrication. Inlet and exhaust valve rockers and cams, eccentric straps, and layshaft are in a state of constant movement, and oilers making their hourly cycle are continually exposed to danger.

Our engine characteristics are as follows: The electric engines, of which there are six, are twin-tandem, four-cycle, double-acting, operating at an rpm of 89.9 and capable of generating 3500 kw, 6600 v of 25-cycle, 3-phase power. Their average over a 24-hour period runs about 3400 kw per engine-hour. We also have 14 blowers driven by twin direct-connected engines having the same dimensions as the electric engines, but operating at 60 rpm instead of 89.9.

The cylinder dimensions are 47-in. diam by 60 in. long, with two inlet valves and two exhaust valves on each. A horizontal layshaft with eccentrics to operate the inlet and exhaust valves is driven through a timing gear of the mainshaft. A 75-ton flywheel mounted on this shaft also helps to give some idea of the size involved. Figure 12 has been prepared to show what we were up against on this problem. Observe the points to be grease lubricated, noting the location of the grease cups. On the electric engine, there are 64 points all told.

In installing the system, the main circuit was clamped around the foundation below floor level, thus avoiding the effects of vibration and movement nearly always present on these engines.

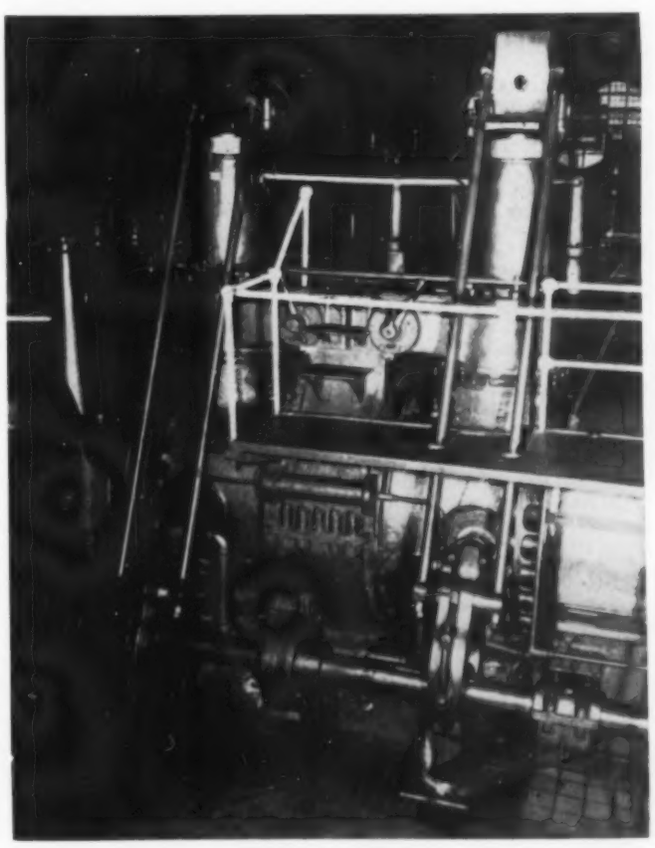
As seen in Figure 13, each feed valve furnishes grease to all points through copper feed lines and hose sections where needed. The only real problem was to describe a path for the lines without exposing them to damage. Figure 14 shows how this was accomplished. Results have been very gratifying. Comparison on grease consumption alone shows the system uses 3.8 lb daily against 12.8 lb with grease cups. In every possible respect—safety, maintenance, efficient lubrication—these installations have justified themselves many times over.

18-IN. MILL DRIVE

Recently some changes were made on our 18-in. mill drive that might prove to be interesting. This mill reduces 4 × 4 in. blooms to 2½ × 2½ in. in six stands, all of which are driven by one 3250-hp motor through a pinion shaft on which are mounted six properly spaced straight-tooth bevel gears. Mating gears drive the mill through long cross-shafting and pinions. The construction of the tee bearings at the gears, cross-shaft bearings and pinion bearings provided wide openings which were not only a constant source of contamination, but which also were very inviting avenues of escape for oil.

Not long ago, we had an oil failure presumably, causing severe wiping of our No. 6, or high-speed, tee bearing. Of course, this condition caused binding on the other bearings in the line as well as misalignment and abnormal wear on the gears themselves. At least five days were required to dismantle all the bearings and bearing shells, reset the bases, change and lap in the

Figure 13 — Grease is fed to all points through copper feed lines.



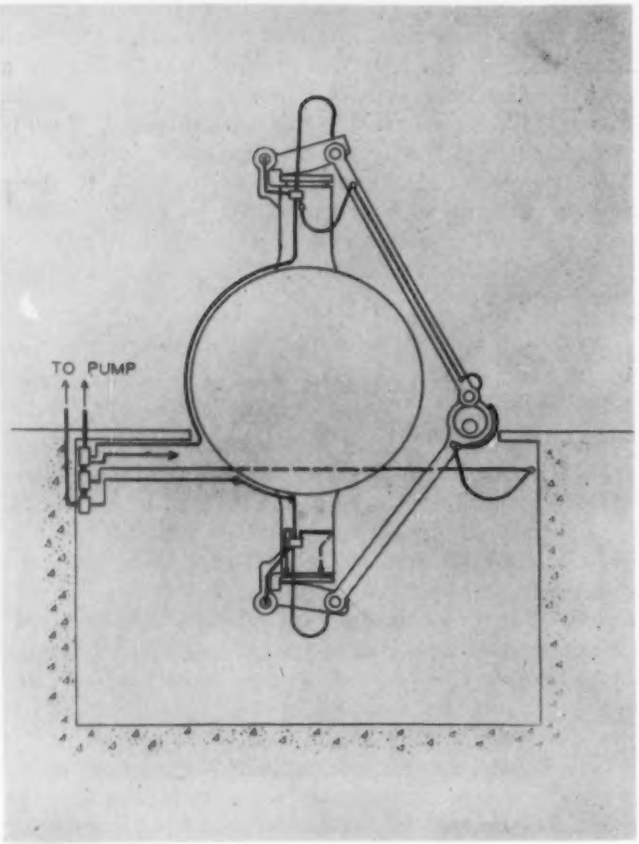
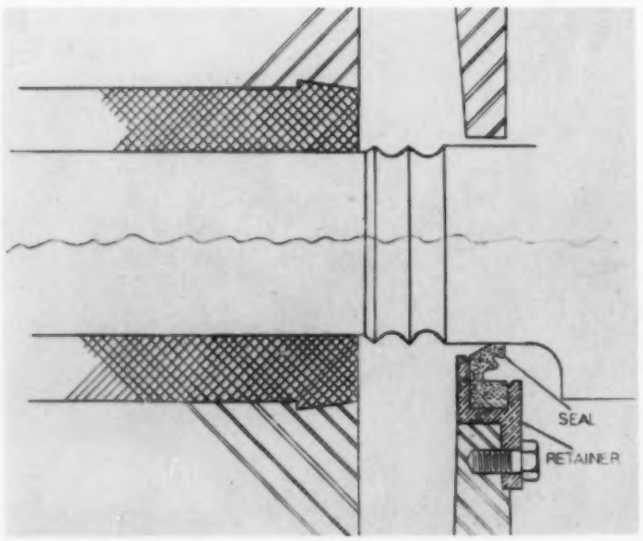


Figure 14 — End elevation shows grease system layout on gas engine.

gear sets. It was decided therefore, to make improvements that would minimize the possibility of repeating a similar breakdown.

In the first place, seals were designed and installed where before wipers were depended upon to keep oil in and dirt out. Split extruded seals were installed, held in place by bronze retaining rings. Although the installation, particularly around the cross-shaft at the tee bearing, required working in areas with very small clearances, the expenditure was worthwhile. All the seals are turned outward and are doing a satisfactory job. Figure 15 shows a section through one bearing.

Figure 15 — Section through bearing on 18-in. mill shows typical oil seal.



Another improvement included the drilling of tee-bearing shells for thermocouple emplacement. In this way we record temperatures of all tee bearings at all times and are assured—as long as the potentiometer is in working order—by an alarm and warning lights that interruption of oil flow will be detected in time to save us from breakdowns. Recorded temperatures at these bearings now reach only a maximum of 135 F.

Gear sprays were also installed for the open bevel gears. We employ a barrel pump, having a lubricant-to-air ratio of 6 to 1. Parallel bronze pipes run along the outside of the gear cover feeding air and product to each spray, through convenient valves located on a platform directly behind the gear sets. Rather than depend on automatic timing devices, we decided to require the oiler to spray as he makes his periodic trips around the drive. Incidentally, since the pinion rotation was upwards on the gear, sprays were first installed underneath; but this location gave us maintenance headaches which were dispelled by placing the sprays above. No harmful effect was noted. Figure 16 shows one in position.

To summarize, lubricant consumption was reduced to one-third on the gears; less oil is lost in the bearing system; cleaner oil is in circulation than before; and, finally, thermocouples attached to alarm and recording devices are improvements that appear to be worthwhile.

RECLAMATION OF BEARINGS

At the AISE Philadelphia District Section Meeting, April 6, 1946 a paper was given on reclamation of babbitt bearings by torch babbitting. See "The Reclamation of Precision Babbitt Bearings by the Gas Flame Method," by R. A. McCarthy, Proceedings AISE, 1945, p 545.

At the time, Mr. McCarthy made reference to the torch babbitting (either oxy-hydrogen or oxy-acetylene) of 30 in. diam hot strip, cold strip, as well as 9½, 10, 12 and 14 in. rod mill bushings. It was pointed out that the method had proved very satisfactory, having the very desirable effect of reducing cost and increasing bearing life.

Even bearings requiring large amounts of babbitt were babbitted successfully by this method. Of course, tinning demands special care and attention at all times, and successful application of this method, like in any other babbitting process, depends almost entirely on tinning and bonding.

Another move intended to improve bearing performance was to reduce babbitt thickness where feasible. It was thought that by employing the torch technique, bearings could be re-designed for thinner babbitts and thereby achieve longer life. With this in mind, we experimented with some of our gas-engine crankpin bearings and improved our performance two and threefold. These bearings, approximately 22-in. diam × 15 15/16 in. long, were originally cast iron or cast steel shells with babbitt linings of ¾ in. plus. It was not uncommon to run across thicknesses of 1½ or 1¾ in. Failed bearings could be characterized as "all cracked up and poor bond."

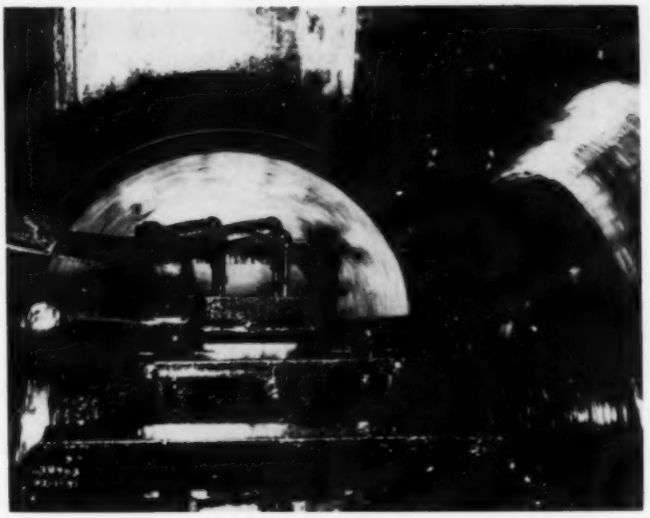


Figure 16 — Sprays were placed above the pinion.

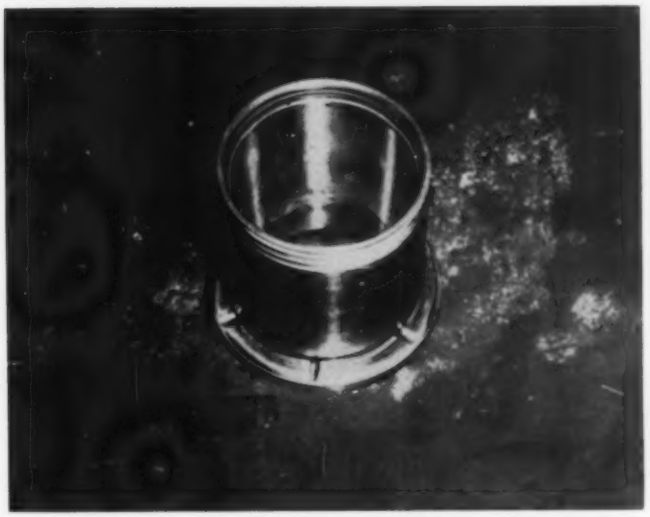


Figure 18 — Chromium plating can be used to restore original dimensions.

It was decided that a bronze shell with babbitt $\frac{3}{16}$ in. thick would have ample strength and otherwise good bearing characteristics to do this job satisfactorily. To complicate matters further, tin was short at the time of the experiment, so that it was decided to use a lead babbitt of 80Pb-15Sb-5Sn composition at the same time. The fact that we are gradually converting all our crankpin bearings to this construction gives a measure of its success. At least double life is obtained. Twenty thousand hours is a certainty unless perhaps an off-babbitt is used or the bonding technique is careless.

Figure 17 shows a pair of these bearings which were bored off center in error but were still placed in service. After 3000 hours, the engine was dismantled for other reasons and the error was discovered. Observe that the bearing surface looks very good even though a thickness of $\frac{1}{32}$ in. was all that was carrying the load in the center of one of these shells.

This practice of reducing babbitt thickness is proceeding slowly, but gradually taking hold. So far, skip-hoist bearings, 60 in. universal mill, vertical-roll, drive-shaft bearings, etc., have been investigated. All results to date have justified our experiments.

CHROMIUM PLATE

Among our more interesting developments was one on rod-mill sleeve bearings. These bearings are an assembly in which tapered sleeves are keyed onto tapered roll necks, the outside diameter of the sleeve, therefore, riding in a babbitt bushing. As you probably know, there are seals on each end of the bearing to keep the oil in and the water and scale out. All went well until the tapered sleeves began to literally stretch and crawl up the neck. By so doing, the end-face seals could no longer function properly and considerable contamination took place, not to mention the fact the bushings themselves had to be scraped larger

Simply chromium plating the inside of the tapered sleeve to restore the original dimensions got us out of trouble. Its cost was much less than a new sleeve. Figure 18 shows one that had been in service for over a year.

Figure 17 — Photograph shows experimental bronze tin babbit gas engine crank pin bearings.

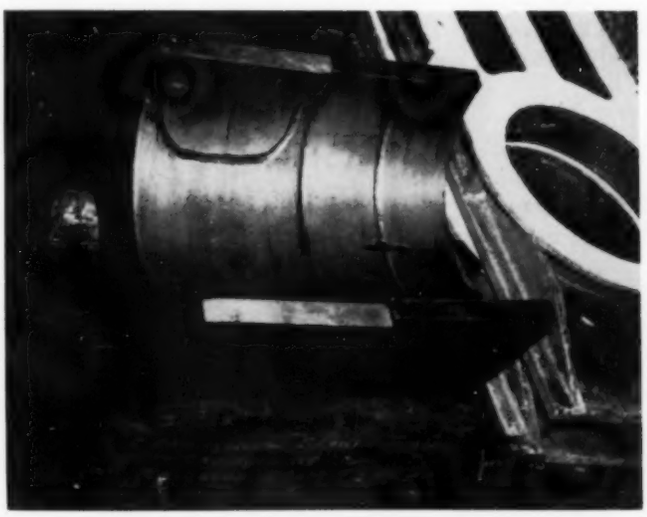
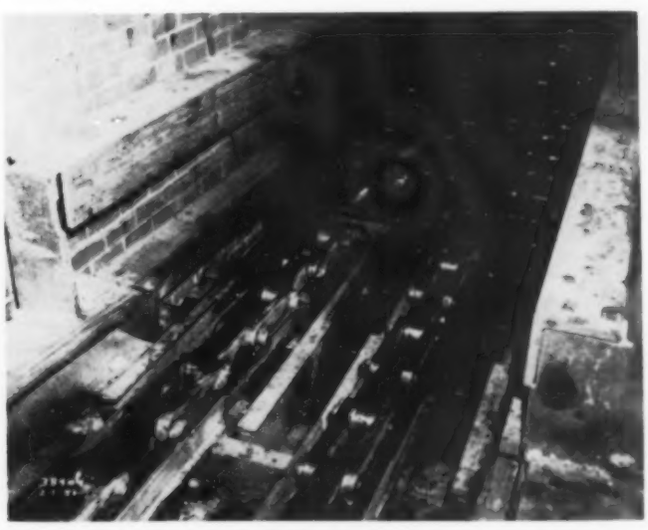
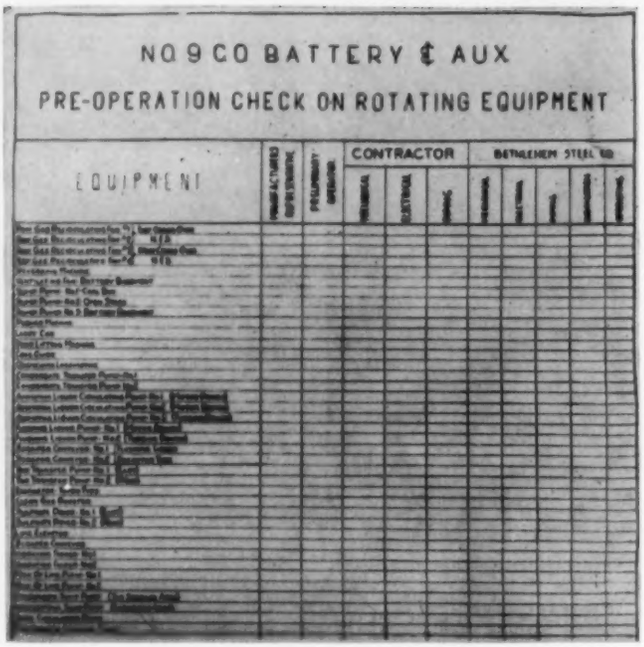


Figure 19 — Colloidal graphite lubrication increased chain life.




NO 9 CO BATTERY & AUX

PRE-OPERATION CHECK ON ROTATING EQUIPMENT

EQUIPMENT

CONTRACTOR

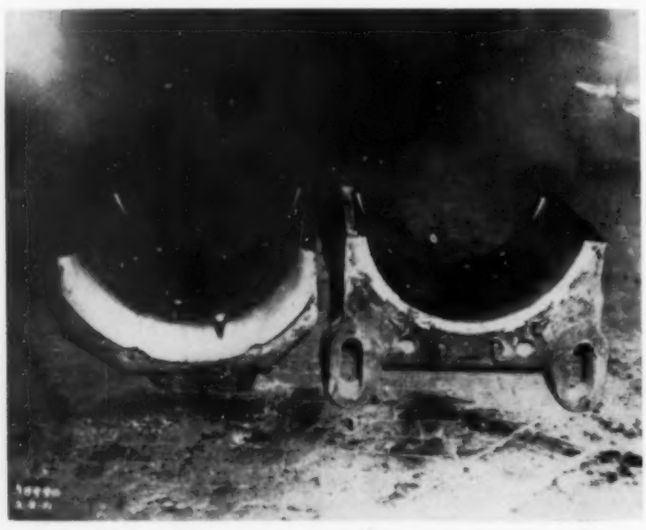
BETHLEHEM STEEL CO

Figure 20 — It is very helpful if the lubrication engineer works with the construction groups when new equipment is installed. The lubrication column on this form insures that the lubrication engineer checks the equipment.

COLLOIDAL GRAPHITE

In our 56-in. hot strip mill an attempt was made to increase the life of the chain and wearing plate on two inclined sections of the hot coil conveyor. There are all told 20 sections of which there are two inclined. Because of the high heat from newly rolled coils and the friction load on the incline, this section of conveyor always had a very short life. Gear compound was used and four applications were made each turn. By resorting to a 50 to 1 mix of red engine oil and colloidal graphite concentrate (10 per cent) we have been able to increase the life of the wearing strip two-fold, already, with no sign of wear. While light oil would burn off, the graphite, which had worked itself into the moving parts, furnished adequate lubrication. In addition, the motor load was reduced considerably by the resulting reduction in friction load. Comparative lubricant cost was identical. Figure 19 shows the chain, one section having colloidal graphite, the other gear compound.

Figure 21 — These bearings have averaged consistently 1,000,000 tons life.



CONSTRUCTION

During construction periods, the starting up of new machinery provides us with special problems. So much pressure is exerted from all directions to place a machine in operation as quickly as possible, that unless some sanity is maintained, something is bound to go wrong. Erectors, mill maintenance crews, electrical construction men, and operators all have a job to do, and sandwiched in between are those of the lubrication engineer whose prime responsibility is to see that no machine starts up unless it is clean throughout and then properly lubricated.

To accomplish this we make use of special charts kept in the construction offices, a sample of which is shown in Figure 20. Note that each unit is named on the chart and in the horizontal line opposite their names there are spaces for the signatures of each responsible party. Unless all spaces have been filled, the unit does not start. This system has worked well on two recent construction projects and will continue in force on all new jobs.

USE OF ALL BABBITT BEARING 40-IN. X 80-IN. SLABBING MILL

The original bearings furnished for this mill were duplicates of those used on a 46-in. blooming mill.

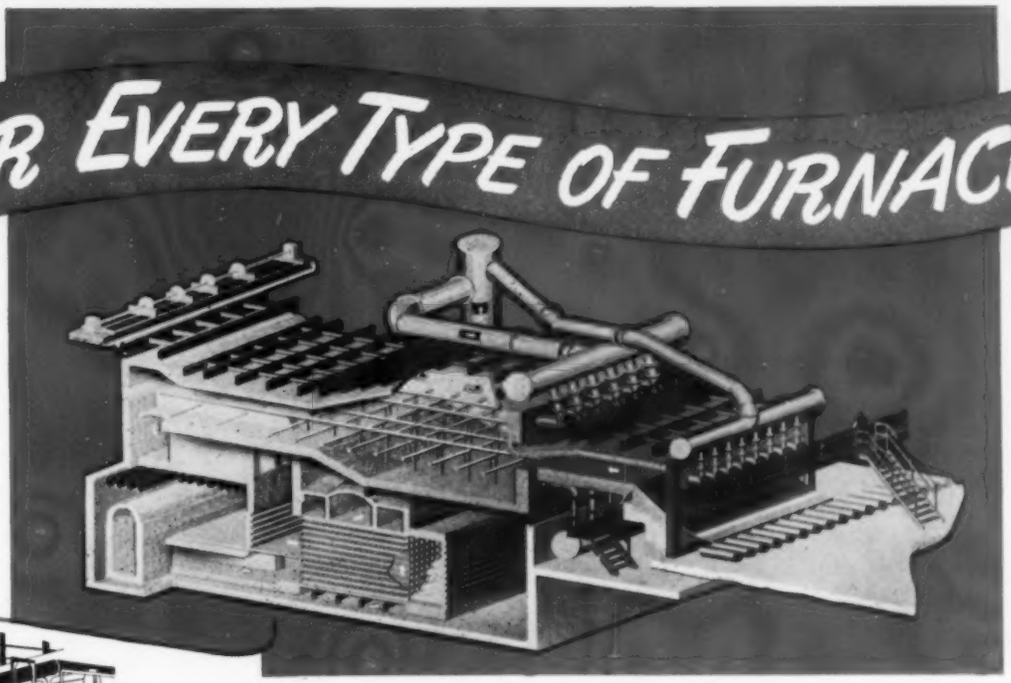
Our early experiences with the 46-in. mill had indicated that some difficulty would be had with the bearings on the 40 × 80 in. mill. These bearings were of the conventional 50 per cent babbitt, 50 per cent bronze-grid type. There were three grids, with grease grooves cut into the two side ones. The center grid was plain. During 1936, 1937, 1938 the mill rolled only on rare occasions. Even so, bearings were changed frequently. However, in 1939 production was increased to supply our hot strip mill with slabs for strip. Troubles with bearings and roll necks became acute. Average bearing life was indicated as 300,000 tons.

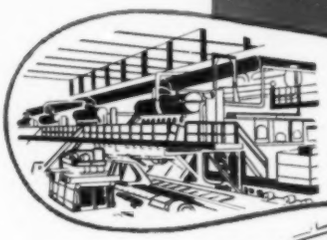
Firecracked roll necks, a major problem, plagued us also.

It was noticed that a very pronounced wear occurred in the radial bearing close to the thrust end. This was three to four times as great as at the wobbler end. The center bronze grid was taken out early in 1940. This showed some benefit. However, life of bearings was not improved to any great extent. Hot necks were fewer and it was felt that we were making progress, but no real success was achieved until the bronze grids were eliminated and an all babbitt bearing was designed.

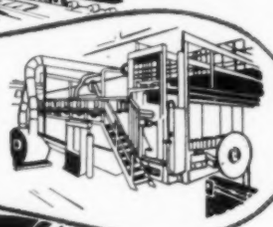
In our work with the grease grooves in the original bearing, we had found it necessary to make wider grooves. It was decided to make the new bearings with four sets of grease feed lines and four separate grooves. The grooves for the radial part of the bearing were cut

FOR EVERY TYPE OF FURNACE

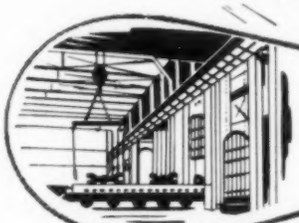




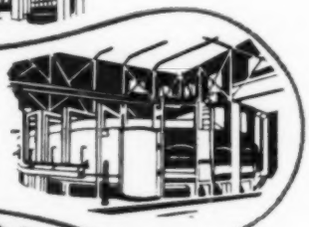
SLAB, BLOOM, BILLET, BAR HEATING FURNACES



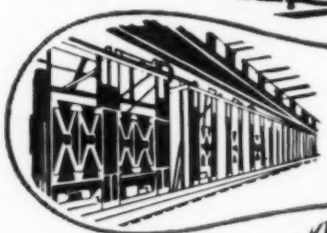
CONTINUOUS PIPE ANNEALING FURNACES



CAR BOTTOM TYPE HEAT TREATING FURNACES



ROTARY HEARTH, BLOOM AND BILLET HEATING FURNACES



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F-2

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into each side of the babbitt. These grooves were 2 in. wide and were cut through the babbitt to the casting, tapering to 1¼ in. at bottom. They extend to within 2 in. of the thrust end and 1½ in. at wobbler end. A separate groove was cut into the thrust area with a separate grease feed for this groove. An additional groove was cut into the radial bearing at the point where this bearing meets radius for thrust bearing. A separate grease feed supplies this groove which is 2 in. wide by 6 in. long.

Since the installation of this type bearing we have tried both tin and lead babbitt, with neither showing to advantage.

The use of this type bearing has entirely eliminated the fire cracking of roll necks. We now discard rolls after full rolling life has been obtained with roll necks showing smooth polished condition. Hot necks have ceased and mill delays due to wiped bearings have become nil. Since this change, we have consistently averaged 1,000,000 tons life for these bearings. Figure 21 shows a pair of these bearings.

In conclusion, very little mention was made of the lubricant itself. This was not intentional, for there have been many problems in which changing the lubricant was the solution, but we find such instances are in the minority. We have found that most of our problems involved improvements in design which in effect permit the lubricant to do the job it is supposed to do.

Finally, let it be understood that developments and improvements such as noted in this paper do not happen overnight, nor are they the product of one man's thinking. Rather, they are the collective efforts of many individuals all the way down to the oiler, millwright or repairman, who more often than not supplies the key to the solution of a perplexing problem.

Thus, what success we have in keeping our equipment and mills rolling during these periods of high production is largely due to the vigilance and cooperation of all the interested personnel.

DISCUSSION

PRESENTED BY

WILLIAM P. KUEBLER, Chief Chemist, Westinghouse Electric Corp., Lester, Pa.

R. J. SIMES, Assistant Superintendent Mechanical Maintenance, Lukens Steel Co., Coatesville, Pa.

L. F. COFFIN, Superintendent Mechanical Department, Bethlehem Steel Co., Sparrows Point, Md.

A. E. CICHELLI, Lubricating Engineer, Bethlehem Steel Co., Sparrows Point, Md.

W. P. Kuebler: I believe all present can realize the necessity of good workmanship and design for the speaker has pointed out the shortcomings of several parts of equipment they purchased. Cleanliness of the oil system is of utmost importance and we all know one will find all sorts of contaminants in a system despite the manufacturer's precautions. One of the major offenders is sand remaining from the sand-blasting operations. The use of sealing paints, to seal in any loose particles that may not come out in cleaning operations is often resorted to.

Such sealers should be oil resistant or oil proof, otherwise they break down, contribute to oil deterioration and also release particles into the oil stream, thus we encounter faulty lubrication and bearing failures.

I have a greater appreciation of what the user of equipment encounters and a most definite picture of how the lubrication engineer can fit into the design, building and use of equipment whether it be a small precision machine or a large rolling mill.

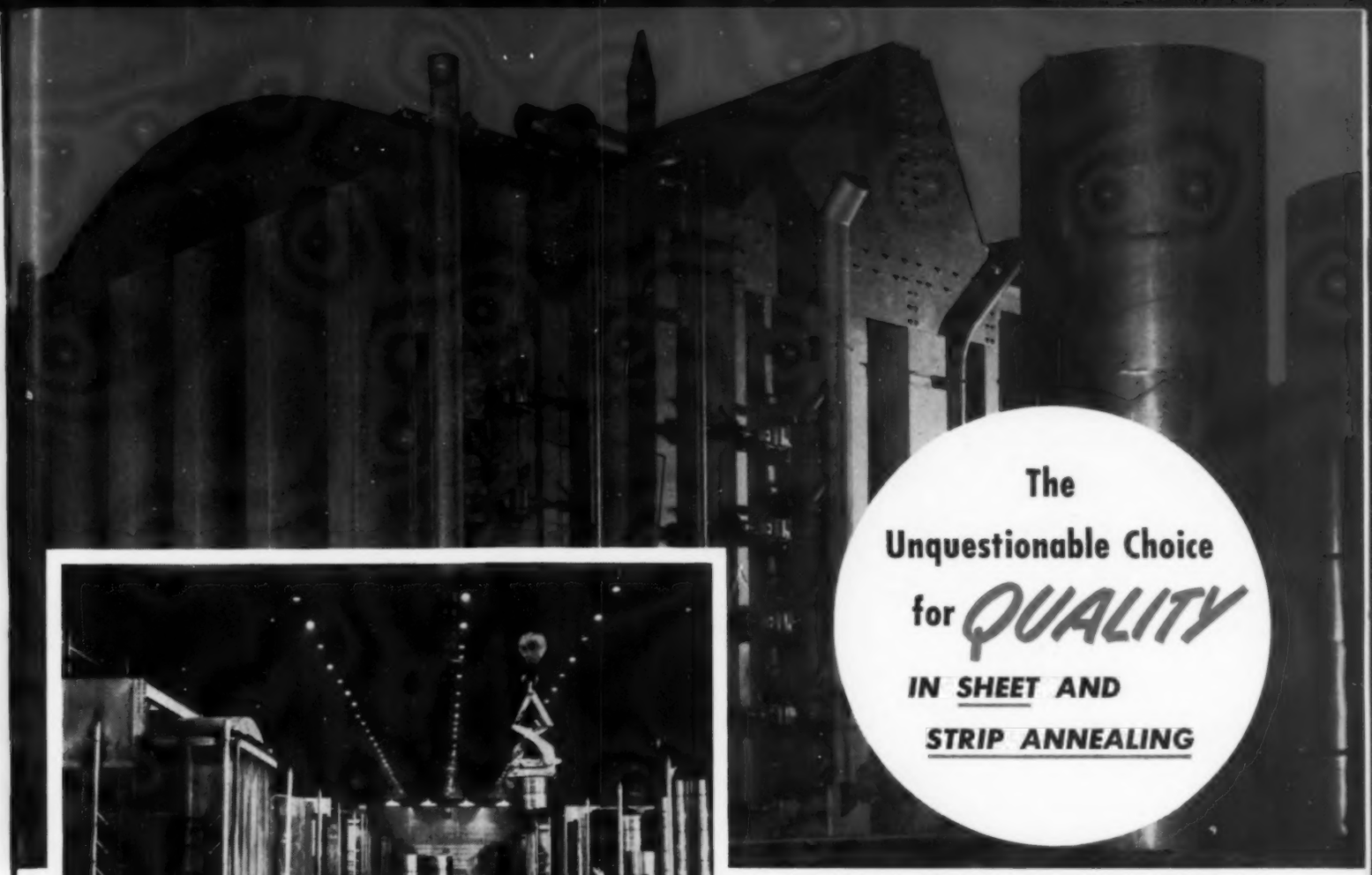
R. J. Simes: What is being done, or what has been done, to remove water and scale from the enclosed table drive housing? Will the author expand on the type of lubricant he is spraying on the gears in these housings?

L. F. Coffin: A lubricating engineer has a manifold job. He has an opportunity to learn the mechanical end of the steel business, as no one else has. He should be a chemist, a metallurgist and a good mechanical engineer —all three combined. I think there is one part of this paper that should be of very great interest and constructive value to those plants where their hot and cold strip mills back up roll bearings are of the oil sleeve type. I refer to the experience with and the tabulation of the oil flows in back up roll bearings. There has been a great deal of misconception about this. We did not know what happened in those bearings until we ran these tests, and we have learned a great deal that has been of value to us.

There is a great tendency in modern high speed mills of higher speeds than those we have at Sparrows Point to go to lighter and lighter lubricants in the back up roll bearings. The 56-in. four-stand, cold strip mill we have at Sparrows Point has a delivery speed of 3000 fpm and we use 2450 sec oil. We are going to reduce the viscosity of the oil down to 1800 sec in order to accommodate the higher speed in the fifth stand when it is added. That is going to mean more oil loss—and we are inclined to think that it may be possible to so re-design the bearings and the passage of the oil flow through them, that you can go back to the 2200 or 2400 viscosity oils, even at those higher speeds. But until you know what does actually happen in the bearings and the very, very small amount of oil that actually does flow through them, you cannot study the problem properly.

A. E. Cichelli: The author appreciates remarks made this evening, and as he sees it, there is only one query requiring an answer.

On the question of keeping water and scale out of enclosed gear drives, it was found in the case under discussion, that the surest way was to eliminate the gear cases themselves. As for the drive I showed on the screen, it had been enclosed and as I stated, we were unable to keep water and scale out of the oil, so we simply eliminated the enclosed drive—and applied an asphalt base open gear lubricant on the gears. It was that simple and that change is what really got us out of trouble.



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UNITED CELEBRATES GOLDEN ANNIVERSARY

▲The enormous growth of the steel industry and the accompanying increase in efficiency of making steel, with lowered costs and resulting expanded steel usage, are accomplishments of which the industry may be proud. It is seldom realized, however, how much these developments have depended on the ingenuity and manufacturing skills of the equipment builder. Typical of the manufacturers who have enabled the steel industry to reach the peaks is the United Engineering and Foundry Co., who this year are celebrating their 50th anniversary.

Back at the turn of the century Isaac W. Frank, a partner in the Frank-Kneeland Machine Co., merged three other companies with his own into the United Engineering and Foundry Co. The birthday of this organization was July 1, 1901. Other companies in the original group included McGill & Co. and Lincoln Foundry Co. of Pittsburgh, and the Lloyd Booth Co. at Youngstown, Ohio. Another company, the Chilled Roll Foundry Co. at Vandergrift, Pa. was merged into the group shortly thereafter. The first president, holding office until 1919, was Isaac W. Frank.

An important factor which set the stage for the equipment builder at that time was the passage previously in 1897 of the McKinley Tariff Act. This act placed duties on imported steel and thus had enabled American manufacturers to compete with British steelmakers, who had had a practical monopoly in this country on many steel products. The result was that many American companies then expanded to supply the American market. There was a need for new and better machinery.

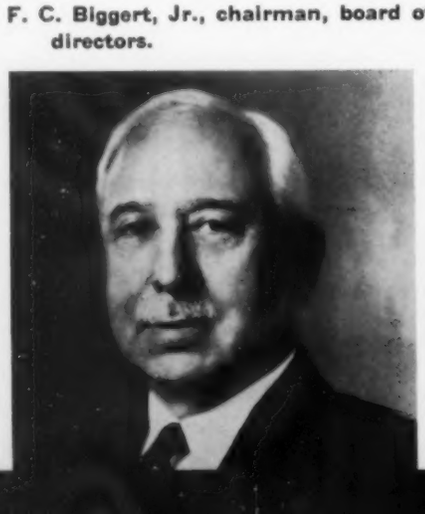
Headquarters for the original company was set up in Pittsburgh at the Frank-Kneeland Plant at 54th Street, which at that time was a thirty minute ride by electric car from the center of town. Present headquarters for the company is a new general office building, designed and built specifically for the company, on Duquesne Way in Pittsburgh. The results of the company's work are exemplified in the file at this headquarters of nearly 200,000 original tracings which give a detailed record of a half century of accumulated engineering knowledge. Here may be found plans for jobs varying from the hinges for the original Panama Canal locks to the hundreds of detailed drawings required for the modern continuous strip mills which have contributed so much to the economy of steel production.

In the many developments reported in this store of engineering knowledge are some which changed manufacturing practices materially and made possible the production of items which could not have been made in any other way. An example of this was the development of a 9-stand, nonreversing rail mill which took the ingot straight through in the early days of the Gary Steel Works in Indiana. This mill was capable of producing 65 miles of rail a day, a rate which could never have been attained with the then common 3-stand reversing mills.

Another development resulted from a request by Lukens Steel Co. of Coatesville, Pa., who asked United to build a plate mill 204 in. wide (52 in. wider than the largest mill then in existence). This mill has since been enlarged to 206 in. Plate mills up until this time had been 3-high, but preliminary design calculations indicated that rolls would be required larger than anyone was able to produce. This resulted in trying a 4-high mill, a design which has since made possible many advances in rolling.

Starting in about 1908, United also acquired patent rights on steam-hydraulic presses, and entered into

F. C. Biggert, Jr., chairman, board of directors.



K. C. Gardner, Sr., president

G. G. Beard, executive vice president

production on simplified, economical units which have become a major item of United's production. One of the outstanding units made by the company is a 14,000-ton press designed to produce armor for battleships.

The continuous strip mill is probably the high point in the equipment which has been developed for the steel industry. These are not the result of any one man's effort, but represent the ideas of many experts, properly coordinated and properly directed to result in an efficient finished unit. A pioneer in this field was Columbia Steel Co. of Butler, Pa., for whom United made a 4-stand, 4-high 36-in. hot mill. The percentage of scrap on this mill was reduced to 20 per cent from the 40 per cent common in the old sheet mill, and labor costs were greatly reduced.

Another early customer was the American Rolling Mill Co., which also played an important part in the development of these mills. John Tytus of Armco had been working on a continuous sheet mill, to which was added a United cold rolling mill for thin sheet, the Tytus mill being used as a break-down mill.

Continuous strip mills have grown in size and speed so there now are units up to 98 in. in width, while the top speeds of cold mills have been increased to as much as 5000-6000 fpm.

Other developments were of course necessary in order to make such units practical. Bearings were always a problem and United was among the pioneers who put roller bearings with grease lubrication on mills of this type. These mills are also dependent for their successful operation on highly precise electrical control and other devices.

In addition to the production of rolling mills, the development of finishing equipment has been an important factor in United's operations. As an example of this, United experimented with a pilot electrolytic tinning line as early as 1937. This led to the continuous electrolytic plating line which United started to build in 1942 for Weirton Steel Co., and which was put into production in 1944. This unit can coat 1050 feet of strip steel a minute. The savings in tin through the use of this process has been a big factor in the conservation of tin supply.

United's work has not been entirely confined to the equipment field. When war came upon the country and defense products were required, United was a major factor in arms production. During World War II United built, for example, more than 8000 105-mm howitzer guns at their Youngstown plant. The New Castle plant also turned out 100,000 150-mm shells and 50,000 8-in. shells a month. The army's biggest mobile gun, the 244-mm howitzer was also made here.

As a result of these advances, in a fifty year period, United has grown from a company which employed about 650 workers in 1901, doing an annual business of about $2,250,000 to an organization which last year sold about $67,000,000 worth of equipment requiring over 5000 employees. Part of this growth came through the acquisition of additional plants and subsidiary organizations. The company now consists of the following units:

Frank-Kneeland Plant—This is one of the charter units and consists of a machine shop which produces rolling mills and auxiliary equipment, molding machines and presses. This plant also absorbed one of the other charter members, McGill & Co.

Youngstown Plant—This unit is the old Lloyd Booth Co., another charter member. It is a heavy machine shop and gear cutting plant. United acquired the Mahoning Foundry in 1906 and Wm. Tod Co. in 1916, and these two units have been absorbed into the Youngstown plant.

Canton Plant—This unit was formerly the American Roll and Foundry Co. which was acquired in 1910. It was enlarged in 1931 through the absorption of the Lincoln Foundry Co., one of the charter companies of United. This plant is an iron foundry and machine shop which produces iron rolls and heavy castings.

New Castle Plant—This unit is a steel foundry and machine shop, which was constructed in 1942 and is operated under a government lease. It produces complete mills, presses, shears, welded equipment and castings.

Vandergrift Plant—This is a steel foundry and roll turning shop and comprises the Chilled Roll Foundry Co., which was acquired in 1902. The plant produces cast steel rolls and other heavy castings.

Adamson Machine Co.—This plant now known as Adamson United, was acquired in 1944 and is one of the largest manufacturers of machinery for the rubber industry. The acquisition of this plant was a step in United's policy to develop new types of machinery and to get into new fields.

Lobdell United Co., Wilmington, Del.—This company was acquired in 1948 and makes calenders and other machinery for paper mills. The unit also makes grinders for rolling mills, as well as pneumatic forging hammers, cutters, etc.

Stedman Foundry and Machine Co., Inc., Aurora, Ind.—This unit makes a large variety of products and produces

K. C. Gardner, Jr., vice president — operations.

M. P. Sieger, vice president— engineering

William Hagel, vice president— sales

Horace Mager, vice president — roll sales

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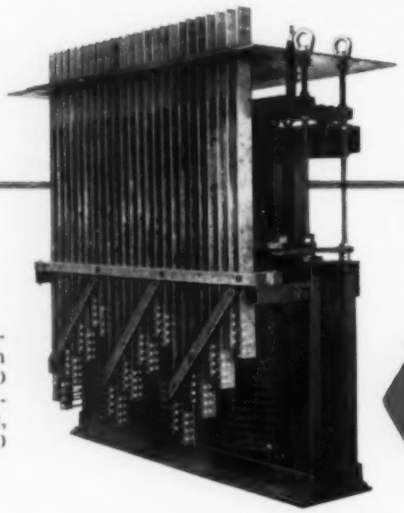

2500 Kva Transformer; High voltage — 3300 volts; Low voltage — 140, 130, 120, 110 and 100 volts.

Fifteen Years Ago... Pennsylvania Transformer Company introduced a new type of helical winding in the low voltage coils of a 2500 Kva furnace transformer. Since then, Pennsylvania has manufactured over 1¼ million Kva of furnace transformers using the same fundamental principles of design employed in this 2500 Kva unit.

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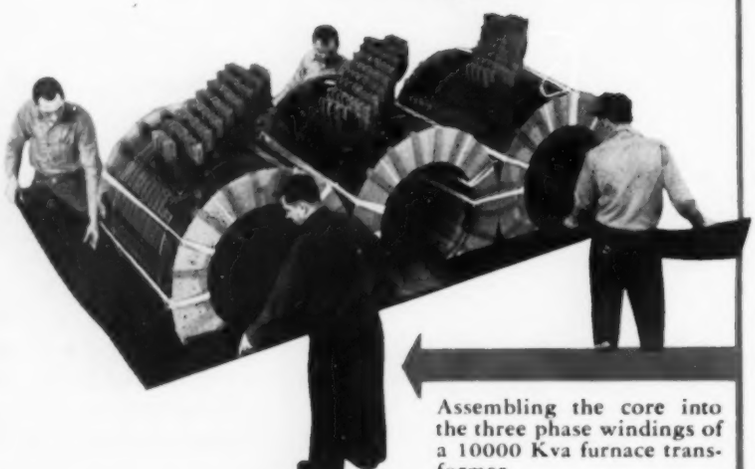
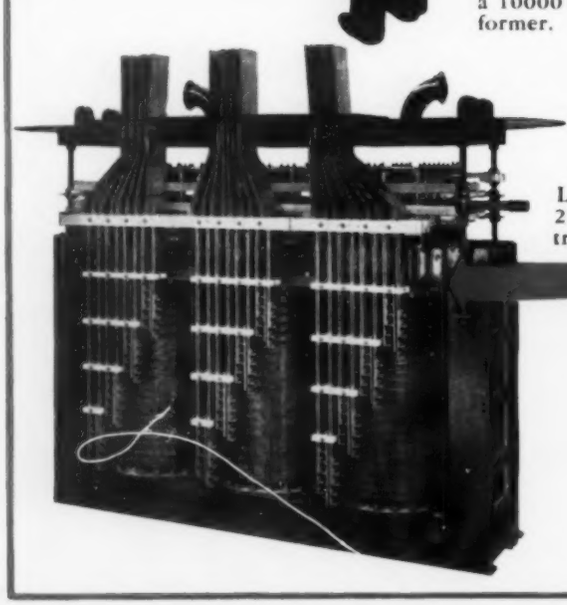


Assembling the core into the three phase windings of a 10000 Kva furnace transformer.



Low voltage side. 25000 Kva furnace transformer.

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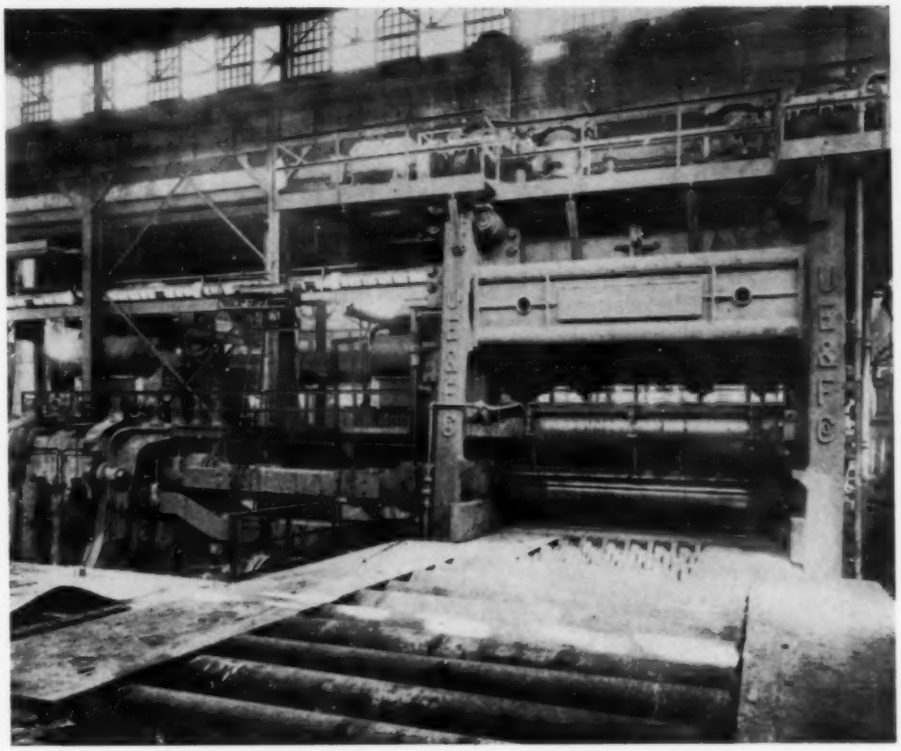


Still the widest mill in the world is the 206 in. plate mill which was built by United for the Lukens Steel Co., Coatesville, Pa. in 1916.

iron castings for machine tool builders, canning machines, printing presses, pumps, valves, tractors and farm equipment. The division also produces grinders, pulverizers, etc.

As a result of acquisitions and growth, United is now in a position to supply equipment not only in this country, but is a major factor in producing equipment for Europe and the rest of the world. In addition to producing steel plant equipment, it furnishes mills and other equipment for the non-ferrous metal producers and fabricators. Developments of new metals and economical introduction of them into the economy will depend to a large degree on the development of machinery which can process them economically.

A key factor in the growth of the company is the vision and experience of the men who direct and manage it. The company at the present time, looks for its leadership to F. C. Biggert, Jr., chairman of the board of directors; K. C. Gardner, Sr., president; G. G. Beard, executive vice president; and K. C. Gardner, Jr., vice president of operations. M. P. Sieger, vice president of engineering, directs the development and guides the engineering know-how which is such an important factor in good equipment. Other leaders are Wm. Hagel, vice president of sales, and Horace Mager, vice president of roll sales who bring in the business which keep the company going.

COATING IMPROVES FORMING OPERATIONS

▲ The great pressures that are required in most forming operations can cause destructive frictional contact between die and metal, resulting in excessive breakage or unduly short die life. Recently it was discovered that by phosphate coating steel prior to working it, drawing, extrusion and other forming operations could be greatly improved. Of great interest and importance to industry is the fact that a protective phosphate coating makes possible the cold extrusion of steel.

Getting cold steel to flow depends on some unique characteristics of this coating. Its non-metallic phosphate crystals are physically and chemically adapted to acquire a strongly adsorbed lubricant. The combination of adherent phosphate coating and adsorbed lubricating film possesses a low coefficient of friction while maintaining its integrity under extremely high deforming pressures.

"Granodraw" is a phosphate coating chemical developed in the research laboratories of the American Chemical Paint Co., Ambler, Pa., for use in drawing operations. On pickled surfaces it forms a tightly-bound, adherent, zinc-iron phosphate coating which facilitates the cold mechanical deformation of steel. This is made possible by the plastic-crystalline structure of the integral "Granodraw" coating and its lubricant adsorptive properties.

"Granodraw" is applied in an immersion or spray process. When used in conjunction with a suitable lubricant, the coating reduces friction under conditions of low, medium, or high deforming forces encountered in such typical operations as: cold extrusion of steel; cold shaping; deep drawing (tubs, cartridge cases, shells, etc.); stamping; drawing of wire and tubing; ironing; necking; nosing; and upsetting.

The following are among the advantages indicated for phosphate coating with "Granodraw" prior to forming steel:

Drawing of wire, bars, tubing, etc.—Improved lubrication; improved surface; less scratching; reduced pull; greater per cent reduction per pass; reduced die wear; longer die life; lower die maintenance and cost; reduction in corrosion.

Drawing of stampings; shells, shell cases, etc.—Improved lubrication; reduced breakage; reduction in scrap; deeper draws; less scratching; elimination of some annealing; less wear on dies.

New Annealing Furnaces Put Into Operation

Operating Cycle Explained Fully

There's something new in the Riverdale Annealing Department—the three Lee Wilson Cylindrical, Forced Convection type annealing furnaces with their eight bases, which were placed into operation around the middle of March.

Annealing of steel is a process involving carefully controlled heating and cooling of the metal in controlled atmospheres which produces soft, ductile steel suitable for forming operations.

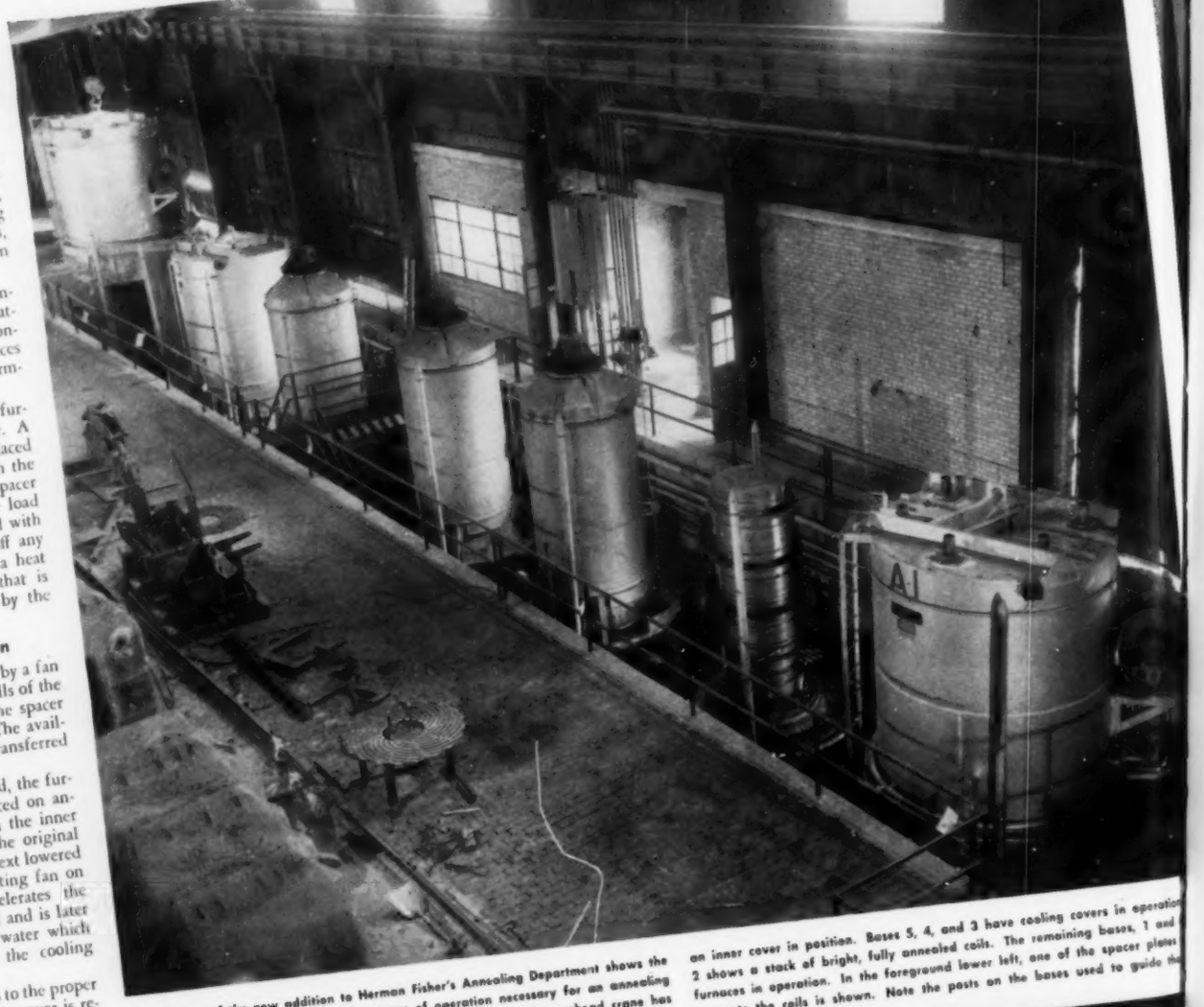
Operation of the annealing furnaces follows a simple sequence. A tall stack or load of coils is placed on one of the eight bases, with the coils separated at intervals by spacer plates of special design. The load to be annealed is then covered with an inner cover which seals off any outside air and also acts as a heat exchanger for the furnace that is next lowered into position by the big overhead crane.

Gases Driven by Fan

Superheated gases driven by a fan are circulated within the walls of the inner cover and through the spacer plates at high velocities. The available heat is thus rapidly transferred to the load by convection.

After the heating period, the furnace is removed and placed on another loaded base. With the inner cover still in place on the original load, a cooling cover is next lowered into position. A circulating fan on the cooling cover accelerates the cooling rate of the load and is later aided by a shower of water which still further shortens the cooling cycle.

When the load cools to the proper temperature, the cooling cover is removed and used to cool another load on another base, and the inner cover is finally removed, exposing the stack of bright, fully annealed coils.



Overall view of the new addition to Herman Fisher's Annealing Department shows the complete installation with the various stages of operation necessary for an annealing cycle. Starting from the back on the last of the eight bases, the overhead crane has lifted one of the three furnaces and is ready to transfer it to the next base which has an inner cover in position. Bases 5, 4, and 3 have cooling covers in operation. 2 shows a stack of bright, fully annealed coils. The remaining bases, 1 and furnaces in operation. In the foreground lower left, one of the spacer plates separate the coils is shown. Note the posts on the bases used to guide the

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Cold extrusion—Improved lubrication; increased strength of parts; improved surface; reduction in load on press; greater dimensional accuracy; more uniform wall thickness; longer extrusions; elimination of some annealing; less corrosion.

TABLE I — APPLICATION

Trade name	For use on	Methods of application	Temperature range, F
"Granodraw"	Iron Steel	Dip spray	180-210

Greater reductions, increased production, less scrap, and higher standards for finished products are some of the outstanding results of the application of the "Granodraw" phosphate coating processes as an aid in cold forming of steel.

The following examples are typical of the improvements in performance made possible by the use of "Granodraw" for cold forming of steel. The phosphated, lubricated cup for a large cartridge case is given an 80 per cent reduction in four passes with no intermediate anneals or surface treatments. Finish is excellent and the total life extended considerably over components formed without the use of the phosphate coating. In another case a cup for a shell is phosphated and lubricated and given a 67 per cent reduction with one pass through two dies.

Such reductions and multiple press operations with but one "Granodraw" lubricant treatment are also commercial practices on other ammunition components such as 50-caliber, 20-mm, 57-mm, and 90-mm cartridge cases, and 60, 81, and 105-mm shells. The recent emphasis on cold extrusion of steel has disclosed that these same parts can be extruded as well as drawn and that the use of the coating is indispensable in the operation.

"Granodraw"-coated fine wire to be wet drawn, is given an 85 - 95 per cent reduction in cross-sectional area at 15 - 25 per cent greater drawing speed. In addition, the appearance and profile of the drawn wire show considerable improvement over uncoated wire drawn with conventional lubricants. One interesting advantage in the use of the phosphate coating is the corrosion resistance imparted to the drawn wire by residual coating adhering to the steel after as many as 13 holes. Loss of such wire because of corrosion during storage has been practically eliminated.

A tube mill is accomplishing a 40 per cent reduction and a mirror-like inside surface with the aid of "Granodraw" coatings. The speed of this draw is over 100 fpm and the die life is considerably longer than when no phosphate coating is used.

Articles to be plated after forming may now be polished in the flat, formed on the presses, and sent to the plating line with no further polishing. The application of a "Granodraw" phosphate coating and lubricant protects the polished surface during press operations, preventing scratches and gall marks from appearing. Since contour polishing and hand buffing are very expensive, their elimination provides considerable savings.

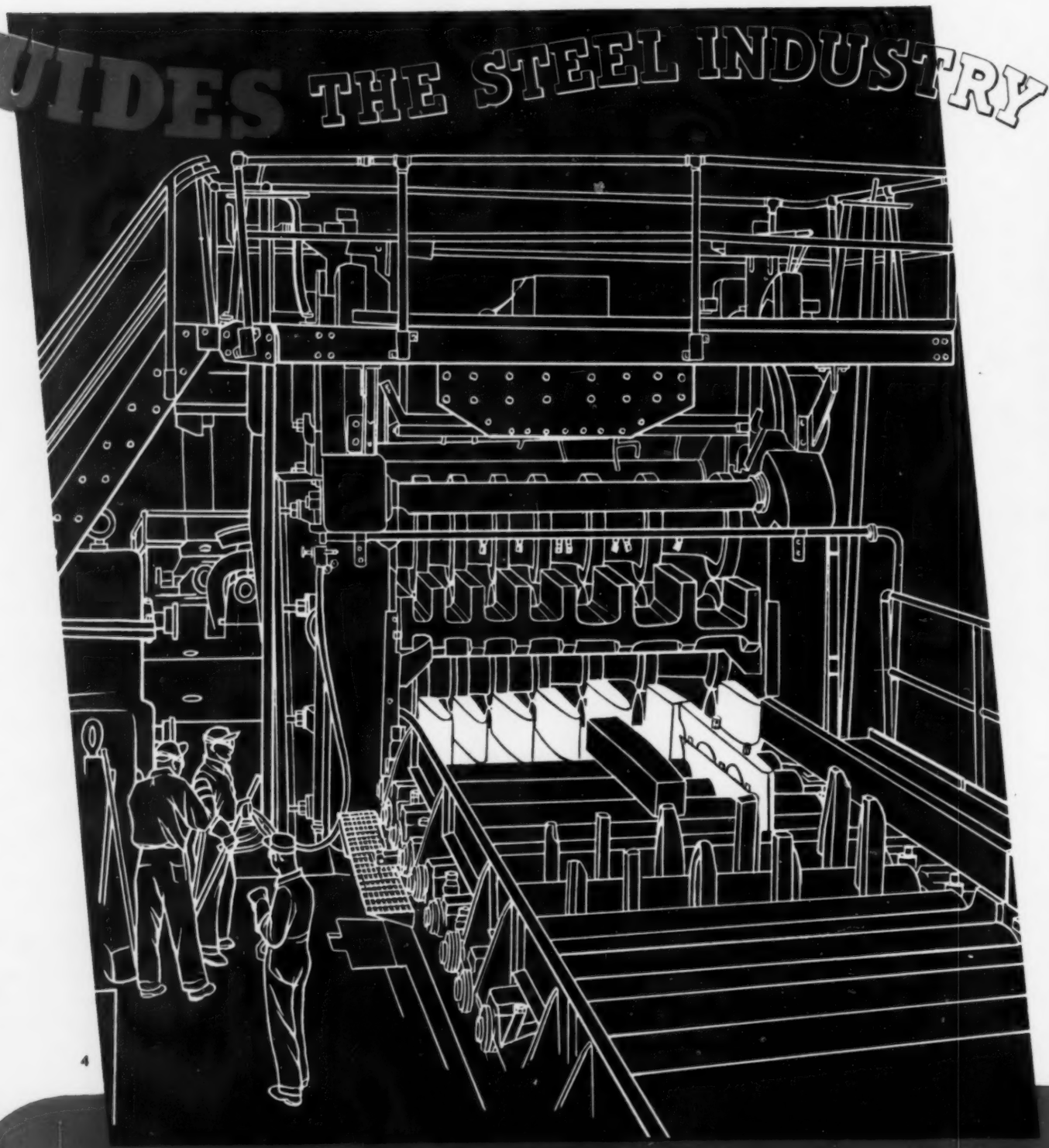
The role of the lubricant used in conjunction with the protective coating is very important. However, it has been found that lubricants such as those in general commercial use, perform in a superior manner with the phosphate coating in preventing contact between tool and work and in reducing friction. With "Granodraw," there is rarely a need for special, high-priced lubricants.

More and more cold forming operations with steel are found to be facilitated with the use of phosphate coatings. Its use is now being extended wherever it is desirable that steel flow smoothly, quickly, and with low friction, to a rigid dimension tolerance and satisfactory finish.

Figure 1 — The drawing of wire and many other forming operations—including the cold extrusion of steel—are greatly facilitated by the application of a phosphate coating and a suitable lubricant prior to working.

TRANTINYL

GUIDES THE STEEL INDUSTRY



Wear-Resistant Tools for the Rolling Mill Industry

Youngstown Alloy Casting Corp. . . . Youngstown, Ohio

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Rolling Mill Equipment ... meets rolling requirements

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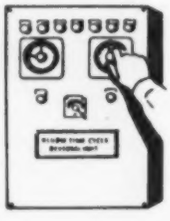
The Bloom Time-Cycle Reversal Unit

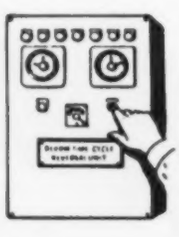
This Compact Factory-Wired Unit

Keeps Open-Hearth Furnaces "Regular"

The field connections are easily and simply made—no complicated wiring is required.



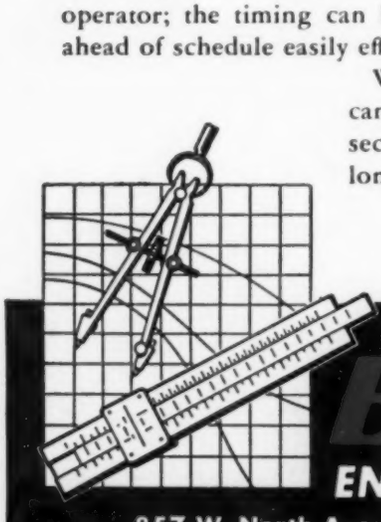
The desired period of firing is readily set up for each end independently, and is maintained until changed by the operator.



In case reversal is desired ahead of schedule, the operator merely pushes the reversal button. After reversal, furnace returns to original timing.

Only a few field connections are needed to install the Bloom Time-Cycle Reversal Unit for open-hearth furnaces, regenerative soaking pits, etc. The compact, factory-wired, dust-proof cabinet shown above contains all the controls, relays, timing devices and other instruments required to perform, in correct sequence, the operations needed for reversing the furnace on a predetermined time cycle. However, the furnace is at all times subject to the control of the operator; the timing can be readily altered, or a quick reversal ahead of schedule easily effected, if desired.

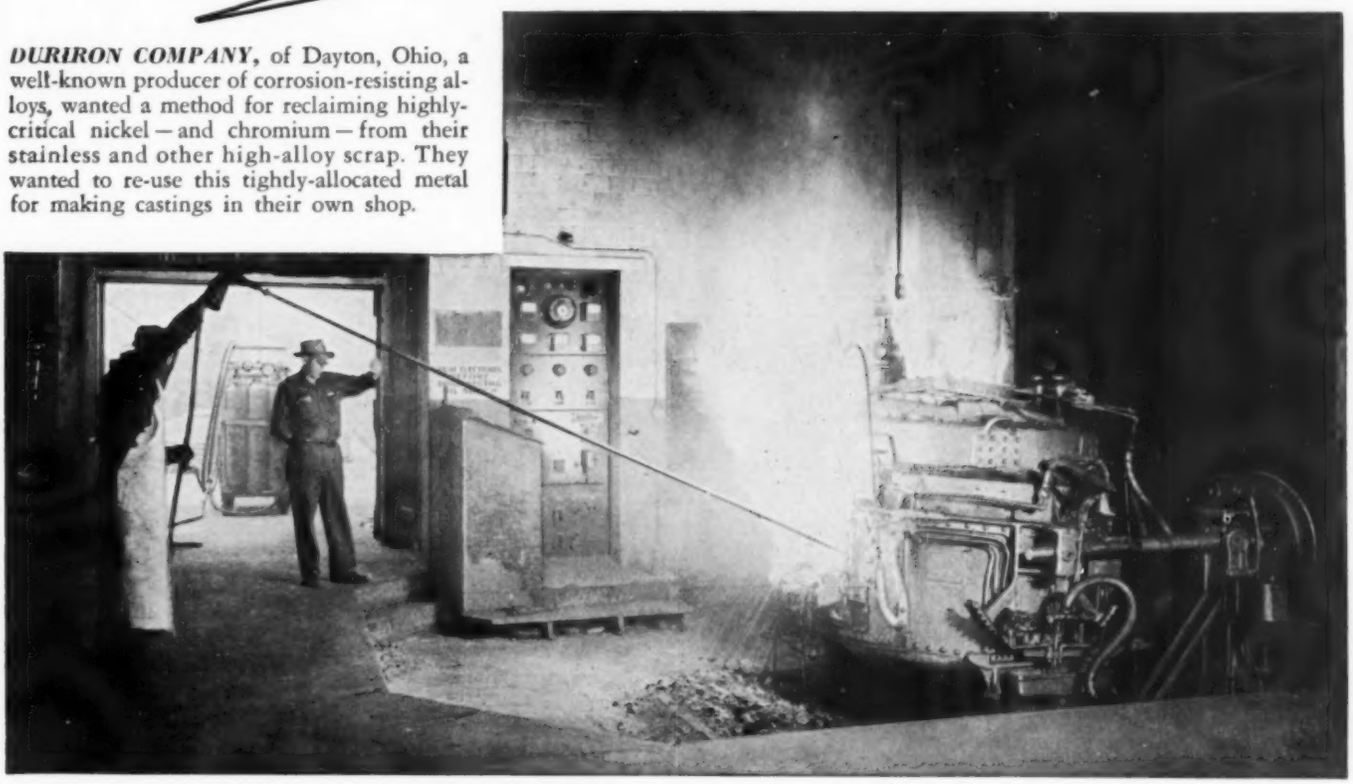
With this system, the average furnace can be completely reversed in nine to ten seconds. This means greater production, longer checker life, greater fuel economy.



BLOOM
ENGINEERING CO., INC.
857 W. North Avenue Pittsburgh 33, Pa.

NEW Airco Oxygen Process reclaims nickel...chromium from stainless and high-alloy scrap

DURIRON COMPANY, of Dayton, Ohio, a well-known producer of corrosion-resisting alloys, wanted a method for reclaiming highly-critical nickel — and chromium — from their stainless and other high-alloy scrap. They wanted to re-use this tightly-allocated metal for making castings in their own shop.



W. T. Bryan, Duriron Co., and ***H. C. Linde,*** Airco Technical Sales Representative, working together, used oxygen refining as a means of removing carbon from the alloy steel bath. On the basis of experience, it was found that the carbon removal was accomplished without excessive oxidation of chromium from the high alloy scrap charge. Equally important, all of the nickel charged was recovered. This permitted the foundry to reclaim all scrap.

The Duriron Company was highly pleased with these results, and have adapted this process as standard practice ... and, now produce low-carbon, high-alloy castings from material that otherwise would be useless to them.

For further information about this modern method for reclaiming high-priority nickel — and chromium — from your scrap, call or write your nearby Airco office for Technical Sales assistance.

AIR REDUCTION

AIRCO

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AIR REDUCTION PACIFIC COMPANY
REPRESENTED INTERNATIONALLY BY AIRCO COMPANY INTERNATIONAL
Divisions of Air Reduction Company, Incorporated
Offices in Principal Cities

The part you *is the thing*

IN KOPPERS ENGINEERING . . . the intangible element, the thing you can't see or can't measure, is one of the most important. We call it sureness.

These 65 new Koppers-Becker Coke Ovens carbonize approximately 1,400 net tons of coal per day at a coking rate of 1.08 inches per hour.

cannot see...

that makes it tick!

SURENESS that guarantees a thorough, dependable job.

SURENESS that provides the most practical solution to the problem.

SURENESS that reduces cost, saves time.

SURENESS that comes *only* with experience.

And look at Koppers experience:

Coke Ovens—Coal-Handling Systems—Power Plants—Blast Furnaces and Stoves—Mills—Open-Hearth Furnaces—Coal Chemicals Plants.

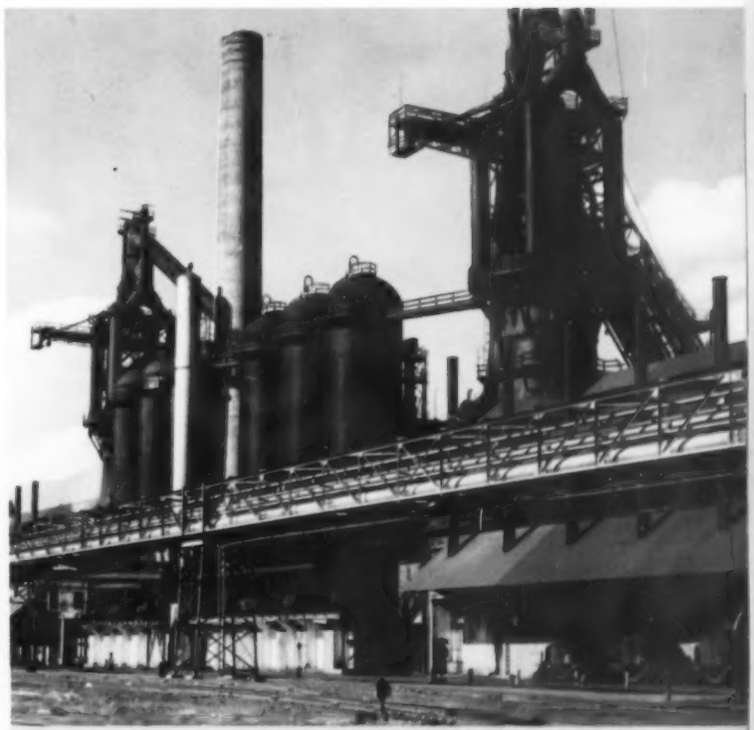
In the construction of such facilities all over the world, Koppers talented engineers developed many modern techniques and new answers to old problems that are now accepted as standards throughout the iron and steel industry.

This pioneering has given industry such equipment and techniques as the famous Koppers-Becker underjet oven, Freyn-designed blast furnace, open-hearth and sintering-plant equipment. And it has given Koppers engineers a SURENESS in their approach to engineering and construction problems that counts in final results.

For any kind of metallurgical construction

YOU CAN COUNT ON KOPPERS

KOPPERS *Engineering and Construction Division*



▲ Typical Freyn-designed and constructed blast furnaces and stoves.

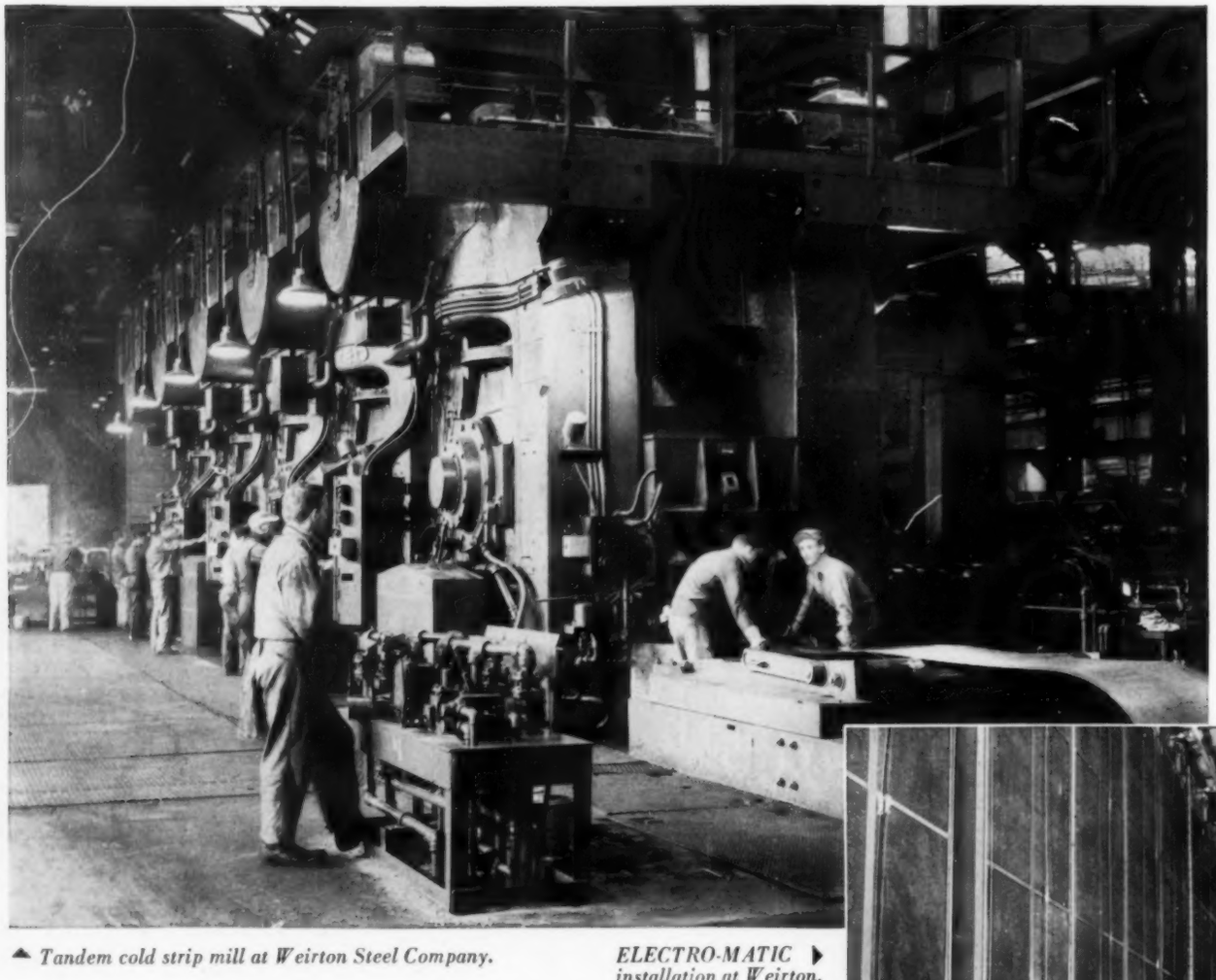
▼ Open-hearth furnaces designed and constructed by the Freyn Engineering Department.

PUT YOUR SHOULDER TO THE WHEEL

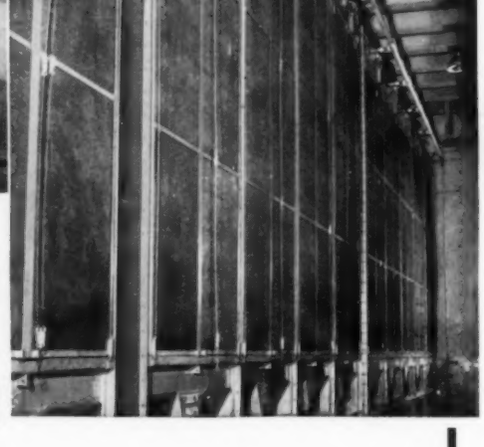
SEND IN SCRAP TO MAKE MORE STEEL!

KOPPERS COMPANY, INC., PITTSBURGH 19, PA.

today's best buy is better air!



▲ *Tandem cold strip mill at Weirton Steel Company.*



ELECTRO-MATIC ▶ *installation at Weirton.*

super-clean air and
HIGH PRODUCTION SCHEDULES!

ELECTRO-MATIC Filters Protect Vital Mill Motors . . . reduce shut-downs and maintenance.

Today, *super-clean* air supplied by AAF Electro-Matic* precipitators protects thousands of mill motors against dust damage . . . and the resulting shut-downs that mean lost tonnage.

Here are the reasons why so many steel companies have installed Electro-Matics for mill motor ventilation. It is the *only* automatic, self-cleaning electronic precipitator and maintains highest cleaning efficiency over a wide range of particle sizes . . . from smoke to the largest air-borne material. Due to Electro-Matic's specially designed collector plates the filter curtain is non-clogging and insures uniform volumes of *super-clean* air. Also, exclusive self-cleaning feature reduces servicing to routine maintenance.

The Electro-Matic is made in standardized self-contained sections, which are easily installed in various arrangements to meet any air volume requirements. These may be equipped with oil clarifiers which continuously clean the Viscosine and simplify sludge removal.

For full story on *super-clean* air protection for mill motors call your nearby AAF representative or write to us for Engineering Bulletin No. 250 F.

***ELECTRO-MATIC** *Automatic Electronic Precipitator.*

AAF

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Metallurgy
Methods
Machines

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Whether your order calls for castings "in the rough" or machined to close tolerances, "Union" always comes through with exactly what the customer requires — *plus* an extra measure of quality due to casting practices and techniques developed and acquired in over 50 years' experience.

"Union" makes better: — GEARS AND PINIONS . . . TONGS AND TONG LEVERS . . . UNIVERSAL COUPLINGS AND SPINDLES . . . CHARGING BOXES . . . PEELS . . . SLAG POTS . . . INGOT AND CHARGING BOX CARS . . . SPECIAL UNIVAN AND ARMOR STEEL CASTINGS.

UNION STEEL CASTINGS

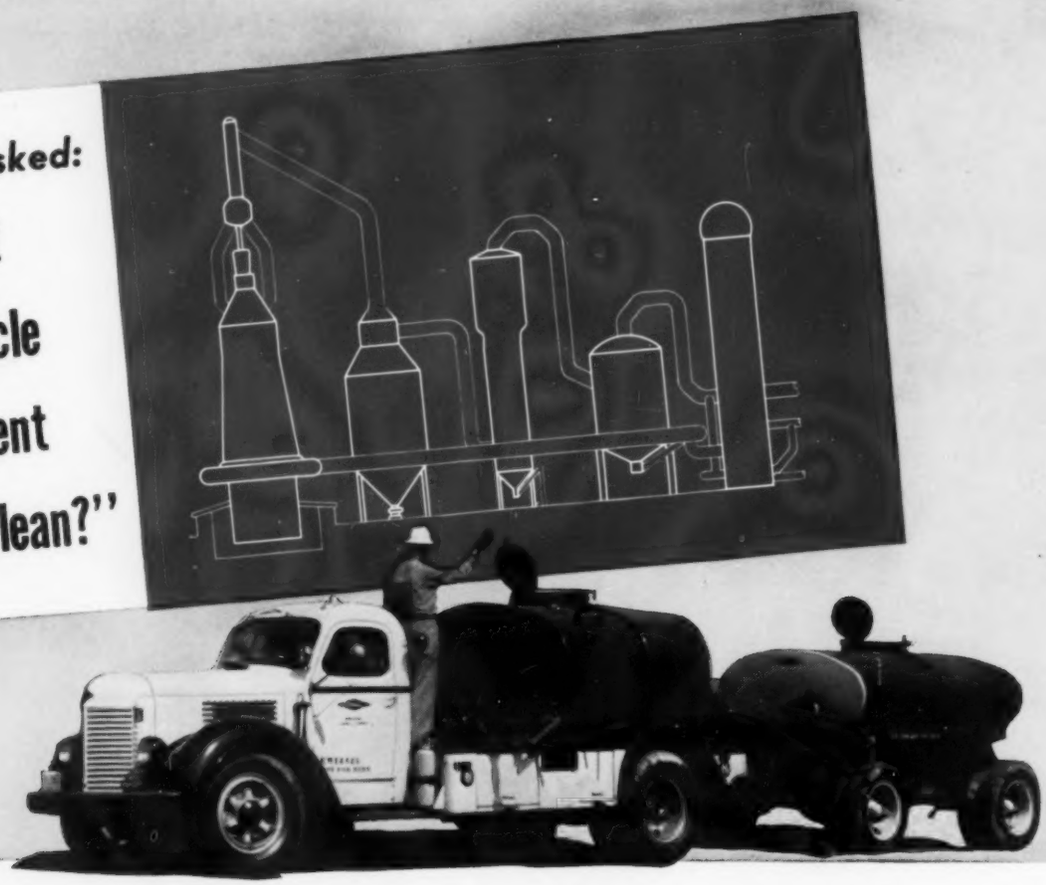
DIVISION OF BLAW-KNOX COMPANY, PITTSBURGH, PA.

DOWELL SERVICE

CHEMISTRY APPLIED TO MAINTENANCE CLEANING PROBLEMS

A Steel Mill asked:

"What Gas Cycle Equipment Can You Clean?"



DOWELL SERVICE has cleaned all types . . . FASTER . . . BETTER

Cleaning of blast furnace gas cycle equipment is a major Dowell Service to the steel industry. Practically every piece of equipment found in the cycle has been cleaned by Dowell Service.

Through the use of solvents, applied by special techniques, deposits can be removed faster and better than by mechanical methods. Dowell engineers are experts in the cleaning of industrial equipment. Dowell furnishes all necessary trained personnel, chemicals, pumps and controls. No special scaffolding is required. Dismantling and downtime are kept to a minimum . . . some equipment can be cleaned while in operation.

BLAST FURNACE COOLING SYSTEMS: Cooling coils and plates were cleaned by using Dowell solvent as coolant. Twenty sections were cleaned in one day, increasing cooling water flow five times.

ELECTROSTATIC PRECIPITATORS: By flooding weirs and ponds with Dowell solvent, caked dust and corrosion products were effectively removed. Dowell Service did the job in 12 hours, saving more than 177 hours over old-fashioned reaming and scraping.

GAS WASHERS: Instead of manual cleaning, Dowell Service pumped solvents directly into the scrubbing water without reducing wind on the furnace or otherwise interrupting operations. Washer was cleaned in four hours.

BLAST FURNACE STOVES: Gas heating efficiency of two stoves was raised from 63.6% and 64.6% to 82.7% and 79% by Dowell Service. The cleaning was accomplished *in four working days, without dismantling the stoves.*

GAS LINES: Another job was on the gas mains from washers to precipitators. Pressure drop on these 48″ and 60″ mains had increased to 17″ of water. Dowell Service cleaned all lines in 8 days bringing pressure drop down to 6″.

DUST COLLECTOR: Dust collector was picking up 5 tons per day instead of rated 30-40 tons. Instead of shut down and manual cleaning, Dowell Service cleaned the collector *in service*, increasing dust pick-up to 30-35 tons per day.

DOWELL INCORPORATED • TULSA 1, OKLAHOMA

CALL

New York 20	Pittsburgh 19	Ft. Worth 2	Mt. Pleasant, Mich.
Boston 16	Detroit 2	Shreveport 69	Hamilton, Ohio
Philadelphia 2	Chicago 4	Atlanta	Charleston, W. Va.
Baltimore	St. Louis 8	Indianapolis	Salem, Illinois
Wilmington 99	Kansas City 8	Louisville	Beaumont, Texas
Richmond 19	Wichita 2	Upper Montclair, N. J.	Borger, Texas
Jacksonville 2	Oklahoma City 2	Anniston, Alabama	Midland, Texas
Buffalo 2	Houston 2	Hattiesburg, Miss.	Wichita Falls, Texas
Cleveland 13	New Orleans 12	Lafayette, La.	Hobbs, N. Mex.

★ *Maintenance cleaning service for industrial heat exchange equipment.*

★ *Chemical services for oil, gas and water wells.*

★ *Magnesium anodes for corrosion control.*

DOWELL

A Service Subsidiary of

THE DOW CHEMICAL COMPANY

Date-line Diary...

November 2

▲ Senator Harry F. Byrd predicted that government spending will exceed federal income by at least $18,000,000,000, in the fiscal year starting next July.

▲ A priority system to provide natural gas for essential industries was turned down by Petroleum Administration for Defense.

November 3

▲ According to Wards Automotive reports, motor truck production for 1951 will be the largest in history.

▲ The NPA cancelled the requirement that producers have to maintain a 10 per cent reserve for filling last minute orders.

▲ United States Steel Co. announced that it will build a steam and electric power plant at the Ohio Works. Completion is scheduled for 1953.

November 5

▲ Based on reports from companies having 93 per cent the capacity of the industry, the operating rate of the steel industry for the week beginning November 5 is scheduled at 101.0 per cent of capacity. This is equivalent to 2,019,000 tons of steel ingots and castings compared with 2,089,000 tons one week ago.

▲ Follansbee Steel Corp. announced a $33,000,000 expansion program which included an electric melt shop, a new blooming mill, and a continuous hot strip mill. Estimated production is about 50,000 tons of hot strip per month.

November 6

▲ Granite City Steel Co. plans to finance a steel expansion program by raising $10,000,000 through sale of $100 par preferred stock.

November 7

▲ Kaiser Steel produced a record 121,463 tons of steel ingots in October by operating its 8 open hearth furnaces at 105.6 per cent of capacity. Mill loadings set a new high of 84,707 tons.

▲ Woodward Iron Co. blew in their No. 4 blast furnace. This is the first commercial blast furnace built in Alabama since 1908.

▲ Ore freighters at Duluth-Superior were jammed up because of freezing temperatures.

▲ Secretary of Treasury Snyder predicted that the government will be $7,500,000,000 in the red in the current fiscal year which ends next June 30.

▲ Anaconda Copper Mining Co. is going into the aluminum business and will take over Harvey Machine Co.'s commitments to build a plant at Kalispell, Mo. Plant will have an initial capacity of 54,000 tons and it's estimated cost is $46,000,000.

November 8

▲ American Railway Car Institute reports that freight car production in October totaled 10,082 or over 10,000 cars for the first time since April 1949. Orders during the month were 3464 leaving a backlog as of November 1 of 132,792.

▲ NPA announced it is considering placing distribution of nation's entire lead supply under government control.

▲ Third quarter earnings of the nation's top steel producers were 42 per cent less than the earnings for the previous year. Earnings for the first nine months were 23 per cent less than they were in the same period of 1950. Federal taxes are responsible for the decline. For the first nine months estimated federal income tax totaled $295,000,000 compared with $147,000,000 in 1950 or just about double.

▲ Under a five-year contract, Allegheny-Ludlum will buy pig iron from Crucible Steel, starting in 1953. Pig iron will be produced in Crucible's new blast furnace.

▲ The CIO asked for a minimum U. S. wage of $1.25 an hour. This is included in the 26 point legislative program approved at the 13th annual CIO convention.

▲ E. W. Bliss was awarded a contract by Pittsburgh Steel for a four-stand tandem cold sheet and strip mill, a single stand temper mill, and a side-trimming shear line for their Allenport, Pa. plant. Annual capacity will be 380,000 tons.

November 9

▲ DPA chief Fleischman announced that tin stockpiling will be discontinued by the government.

▲ Commerce Department reports that business inventories fell $250,000,000 in September leaving a total inventory at the end of the month of $69,300,000,000.

▲ U. S. Steel Corp. announced that it will simplify further its corporate structure effective January 1, 1952. Most of the present subsidiary companies will become operating divisions of the United States Steel Co.

▲ Kaiser Aluminum Chemical Corp. announced a $100,000,000 expansion program which will double present 100,000-ton capacity at its New Orleans plant.

November 10

▲ Ceiling price of brown iron ore went up 2¢ per long dry ton effective today.

November 11

▲ New England Steel Corp. received an extension of its certificate of necessity for proposed new plant —an additional two months from today.

November 12

▲ According to the AISI, the operating rate of the steel industry beginning November 12 is 101.1 per cent of capacity. This is equivalent to 2,021,000 tons of steel ingots and castings compared with 2,019,000 tons one week ago.

▲ F. W. Dodge Corp. estimates that construction dollar volume in the 37 states east of the Rockies will run 10 per cent less in 1952 than in 1951.

▲ The 13-day old strike of Tennessee Coal, Iron and Railroad Co. ended today.

November 13

▲ International Materials Conference estimates that sulphur shortage will continue through 1952, estimating demand then of 7,596,000 tons compared with production of 6,255,600 tons.

▲ AISI estimated that steel production in 1951 will total about 106,000,000 tons and by 1953 should reach 123,000,000 tons.

▲ The Aluminum Association reports that September production of aluminum was 138,857,530 lb which is about 6 per cent under August. Aluminum sheet and plate shipments in September totaled 77,670,405 lb.

▲ Kaiser Steel Corp. reports net earnings for the quarter ending September 30 of $2,515,677 after

federal income taxes. Total sales were $29,499,430.

November 14

▲ DPA announced that steel producers will be given all the structural steel they need for expansion projects in the first quarter of 1952.

November 15

▲ OPS authorized construction industry to adjust prices to reflect increased material and labor costs.

▲ British Steel production declined to an annual rate of 15,629,000 tons in October slightly under the figure for September and well under October 1950.

November 16

▲ The CIO is seeking in addition to other benefits, a guaranteed annual wage from the steel industry. Twenty-two contract demands have been drawn up by the CIO.

November 19

▲ The operating rate of the steel industry is scheduled at 103.7 per cent of capacity for the week beginning November 19. This is equivalent to 2,073,000 tons of steel ingots and castings compared with 2,021,000 tons one week ago.

November 20

▲ Harnischfeger Corp. is aiming at a sales volume of $60,000,000 this year which will be far the best in its history.

▲ American Iron and Steel Institute reports that wage earners received an average of $1.974 an hr in September, which is 4¢ higher than the 8-month average. Workers worked an average of 39.1 hours per week. Total employment was 676,700.

November 21

▲ President Truman approved lead sales to industry of 30,000 tons from the military stockpile.

▲ Commerce Department reports that government will run $4,000,000,000 in the red during the fiscal year ending June 30. This contrasts with recent estimate made by Treasury Secretary Snyder.

▲ Republic Steel Corp. declared a year-end dividend of $1.75 on the common stock in lieu of the regular quarterly dividend.

▲ Republic Steel Corp. issued an additional $5,000,000 worth of 3 per cent promisory notes to General Motors Corp.

November 23

▲ DPA announced that the U. S. will allot more steel to Britain in the first quarter of 1952 in return for aluminum from Canada. U. S. allotment to Britain consists of 25,000 tons of finished steel products and 46,000 tons of ingots, as well as 28,500 tons of scrap which the U. S. was scheduled to receive from Germany.

▲ Production of Canadian pig iron increased slightly in September to 212,485 tons, compared to 199,415 tons in September 1950.

November 24

▲ The NPA ruled that after next April 1 small users of steel, copper and aluminum may be relieved from job of filing long application forms. Under the new rules companies may certify their own orders if they do not use more than 30 tons of carbon steel, 8 tons of alloy steel, 3000 lb of copper and 2000 lb of aluminum in a quarter.

▲ The Granite City Steel Co. offered its common stockholders subscription rights to approximately $10,000,000 worth of its 5½ per cent accumulative preferred stock with par value of $100 a share.

▲ NPA cut down on slab zinc distribution and after January 1 agency's approval will be required for slab zinc deliveries exceeding 10 ton a month. Present figure is 20 tons a month.

▲ DPA authorized rail equipment makers to build 24,200 freight and tank cars in the first quarter of 1952, but allotted only enough material for 21,200 units.

November 26

▲ F. W. Dodge Corp. reports that in the first ten months of 1951, construction showed an 11 per cent gain in the 37 states east of the Rockies with a total of $13,585,024,000.

▲ Pittsburgh Steamship Co.'s 647 ft, 9000-gross ton ore carrier Philip R. Clarke was launched today.

▲ According to the AISI and based on reports from companies having 94 per cent capacity of the steel industry, the operating rate is scheduled 104.0 per cent of capacity for the week beginning November 26. This is equivalent to 2,079,000 tons of steel ingots and castings compared with 2,073,000 tons one week ago.

November 27

▲ Labor negotiations started today between the CIO United Steelworkers and the United States Steel Corp.

▲ Acme Steel Co. of Chicago formed a new division the Acme Steel Products Div. which becomes effective January 1. This will be a sales and distributing company for steel strapping, tools, accessories, etc.

▲ Defense Mobilizer Wilson stated that the government does not contend that there is an overall shortage of steel and never has. He did state that there were shortages of some items.

▲ Pittsburgh Steel Co. shut down seven of its open hearth furnaces until about December 22 when a new blooming mill will begin operation.

November 28

▲ The American Institute of Steel Construction reported that October shipments of fabricated steel totaled 241,411 tons, bookings were down slightly from September at 182,894 tons. The total backlog on October 31 totaled 2,640,851 tons of which 1,052,788 tons were scheduled for fabrication within the next four months.

▲ The John G. Munson, a 666-ft, self-unloading, 20,000-gross ton, limestone carrier was launched today.

November 29

▲ Chairman Linden Johnson of the Senate Preparedness Sub-committee announced that defense output lagged, particularly in airplanes, tanks, guns, etc. The report was highly critical.

▲ Westinghouse Electric Corp. arranged to borrow $250,000,000 from a group of institutional investors. This loan will be used to finance the company's $296,000,000 expansion program.

November 30

▲ Ceiling price regulation No. 98 issued by OPS covers intermediaries and the resale of iron and steel products. The prices issued may result in certain rollbacks, particularly for warehouses.

▲ Bureau of Labor Statistics reported that workers in the iron and steel industry were among the nation's highest paid workers. Plant workers in January earned an average of $1.79 an hour compared with $1.497 for all manufacturing workers.

▲ Eric Johnston, in resigning his post as economic stabilization administrator, said that wage and price controls will be needed for another two years.

▲ Ohio River Steel Corp. closed down one of its four open hearth furnaces at Toronto, Ohio because of scrap shortage.

▲ Ford Motor Co. announced layoffs of 23,000 employees for an indefinite period while changing over to new models.

STOP RUST WITH RUST-OLEUM

Why let rust—the most destructive enemy of American [illegible] —rob you of [illegible] machines, tanks, stacks, fences, pipe, metal sash, fire escapes, and other valuable equipment?

Use RUST-OLEUM in your plant to protect your property. For 25 years RUST-OLEUM has proved its capacity to stop rust for many nationally known manufacturers. Its tough, pliable, rust-resisting film gives excellent protection that prevents rust losses under many difficult rust-producing conditions—salt air, dampness, industrial fumes, and general weathering.

RUST-OLEUM can be applied *even* over rusted surfaces. It is not necessary to remove all the rust. Just remove scale and loose rust by [illegible] and wire brushes. You save time and labor on maintenance because no chemical precleaning or sand blasting is usually required.

A qualified RUST-OLEUM specialist will [illegible] your rust problems and help you develop a program of plant-wide rust control to defer many costly replacements — to conserve the available supply of new metal for national defense.

Industrial Distributors in principal cities of the United States and Canada carry complete stocks for immediate delivery. Plan your needs—order *now!* See our complete catalog in *Sweet's* which also tells the nearest source of supply. Or, write on your company letterhead for full information.

Available in many COLORS aluminum and white

Beautifies as it Protects

"RIGID ECONOMY, MON!"

RUST-OLEUM CORPORATION
2442 Oakton Street, Evanston, Illinois

Is UPKEEP COST your magnet problem?

Although it looks and lifts like new, this Ohio Magnet is actually 22 years old. Until recently, upkeep cost was zero. Then a ground developed in the terminal box and the magnet was shipped to our plant, where repairs were quickly completed without disassembly.

Upkeep cost? Under $100—*less than $5 a year for 22 years!*

Next time you buy a lifting magnet, remember that heavier construction assures extra years of low-cost life. Send your order to Ohio—*27 years a leader in magnetic materials handling.*

This magnet averaged less than $5 a year!

OHIO PROTECTO-WELD MAGNET is welded *on top*, where weld cannot be dented in. Sizes include 39, 46, 55 and 65-inch diameters. Ohio also builds magnet control equipment.

In addition to lifting magnets and control equipment, Ohio Electric also makes fractional horsepower motors, heavy duty electric cable hoists, nail-making machines and drill presses.

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CHESTER BLAND, *President*

Ohio ELECTRIC

A-2012

Industry News...

U. S. STEEL SUBSIDIARIES TO BECOME DIVISIONS

▲ Further steps in the program of simplifying the corporate structure of United States Steel begun a year ago were announced by Irving S. Olds, chairman of the board of United States Steel Corp.

"It is intended," Mr. Olds said, "that as soon as practicable United States Steel Corp. will become primarily an operating corporation with its present activities relating to mining and steel production, fabricating and distribution conducted by general operating divisions. Mr. Benjamin F. Fairless is president of United States Steel Corp., which owns all of the stock of the several subsidiaries which now conduct such operations.

"On January 1, 1952, as the next step in this direction, these wholly owned subsidiaries will become general operating divisions of United States Steel Co., the major subsidiary involved. Mr. Fairless is also president of United States Steel Co.

"The names of most of these new operating divisions will correspond with those of the present subsidiaries involved in this reorganization. The present head of each subsidiary will continue in most instances in a similar capacity with the new general operating division, with the title of president of such division, and with his headquarters continuing at its present location.

"This reorganization, which is entirely internal in character among 100 per cent owned subsidiaries, will neither affect present customer relationships, nor change the present stock interests of the stockholders of United States Steel Corp."

PITTSBURGH STEEL BUYS TWO SLAB FURNACES

▲ Two slab heating furnaces will be constructed for the Pittsburgh Steel Co.'s new 66-in. hot strip mill at Allenport, Pa., according to Rust Furnace Co., the designer-constructor.

The new furnaces, of the Rust continuous type, will be zone-controlled, triple-fired, end charged and discharged, with a heating capacity in excess of 100 net tons per hour each.

They will use preheated air by means of refractory tile recuperators located beneath each furnace. Furnaces will be 22 ft wide inside with an effective heating length of 80 ft in the hearth.

CASTING REPRESENTATIVES HOLD ANNUAL MEETING

▲ The annual research meeting of the manufacturers of Meehanite castings held under the auspices of the Meehanite Metal Corp., convened in New York, N. Y., November 7-10. Over 150 representatives of Meehanite foundries in the United States, Canada and Mexico heard the presentation of some 40 papers on the subjects of management, product development, foundry practice, engineering, metallurgy and casting sales.

Saturday, November 10, was devoted to a plant visitation in the Barnett Foundry & Machine Co., Irvington, N. J.

During the meeting, it was announced that the DeLaval Steam Turbine Co., Trenton, N. J., were about to undertake the manufacture of Meehanite castings. The formation of the Meehanite Metal Co. of Japan, Ltd., under an agreement with Mitsui Shipbuilding and Engineering Co., Ltd., was also announced.

SEEK MORE SUPPLIES IN STAINLESS STEEL FIELD

▲ Further intensification of metallurgical research in the specialty and stainless steel fields on the part of steel companies themselves and company-sponsored laboratories in colleges and universities has been reported by the committee of stainless steel producers of the American Iron and Steel Institute.

Purpose of the intensified research,

FIRST ROLL FOR FAIRLESS WORKS

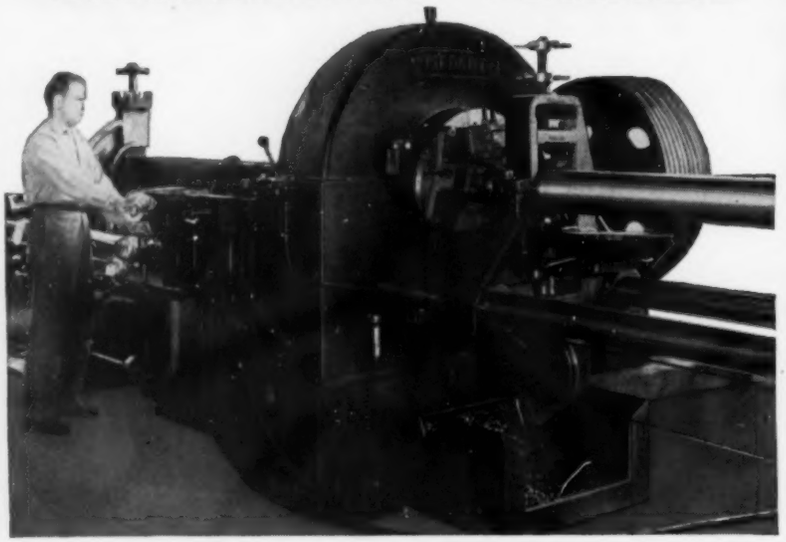
First large roll for the new Fairless works of U. S. Steel near Morrisville, Pa., is about to be hoisted from the lathe for shipment from the Canton roll and machine works. Pete Chovane, left, and Ernest Ranft get ready to secure the heavy chains around the 12-ton roll as Bill Baker, center, directs the craneman. These work rolls are cast from electric furnace molten steel, following which the rough castings are machined to minute specifications at the Canton, Ohio plant.

Fully Automatic
Centerless Turning & Peeling!

. . . for bars and tubes from
1" to 9" diameter, and larger

MEDART

MODEL RFRG
CENTERLESS TURNER



- For high production superior finish, close-tolerance turning or rough peeling. Workpiece size and throughput speeds are limited only by capacity of cutting tools.
- New direct-drive roll-feed with patented Universal Centering Device insures continuous, positive feed and automatic centering of workpiece in cutterhead.
- Separate variable drives for feed and cutterhead give exact ratios between cutter speeds and bar feeds.
- Either 1 or 2 removable cutterheads may be used, with from 1 to 10 cutters for maximum cutting flexibility. Either carbide or high-speed tools are used.
- Eliminates time lost in loading and unloading. Automatic input and output grip carriages permit constant end-to-end feed and delivery.
- Fully automatic push button control from central operating station.

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the committee pointed out, is twofold: one, to make available to essential defense purposes as much stainless and high alloy steel as possible; and, two, to assure supplies of stainless steel for worthwhile civilian purposes. Of the primary alloying elements used in the production of these steels, three—chromium, nickel, and columbium—are imported to the United States.

Properties, such as resistance to temperature extremes and resistance to corrosion which these alloying elements give to stainless steels, make them essential components. These elements permit such steels to withstand unusual torture and treatment.

While production capacity for such steels is being pushed to the limit, research engineers are seeking solutions to metallurgical problems arising from high-temperature applications, such as those in jet engines, and from extreme corrosive conditions.

STEAM POWER CAPACITY INCREASED AT CRUCIBLE

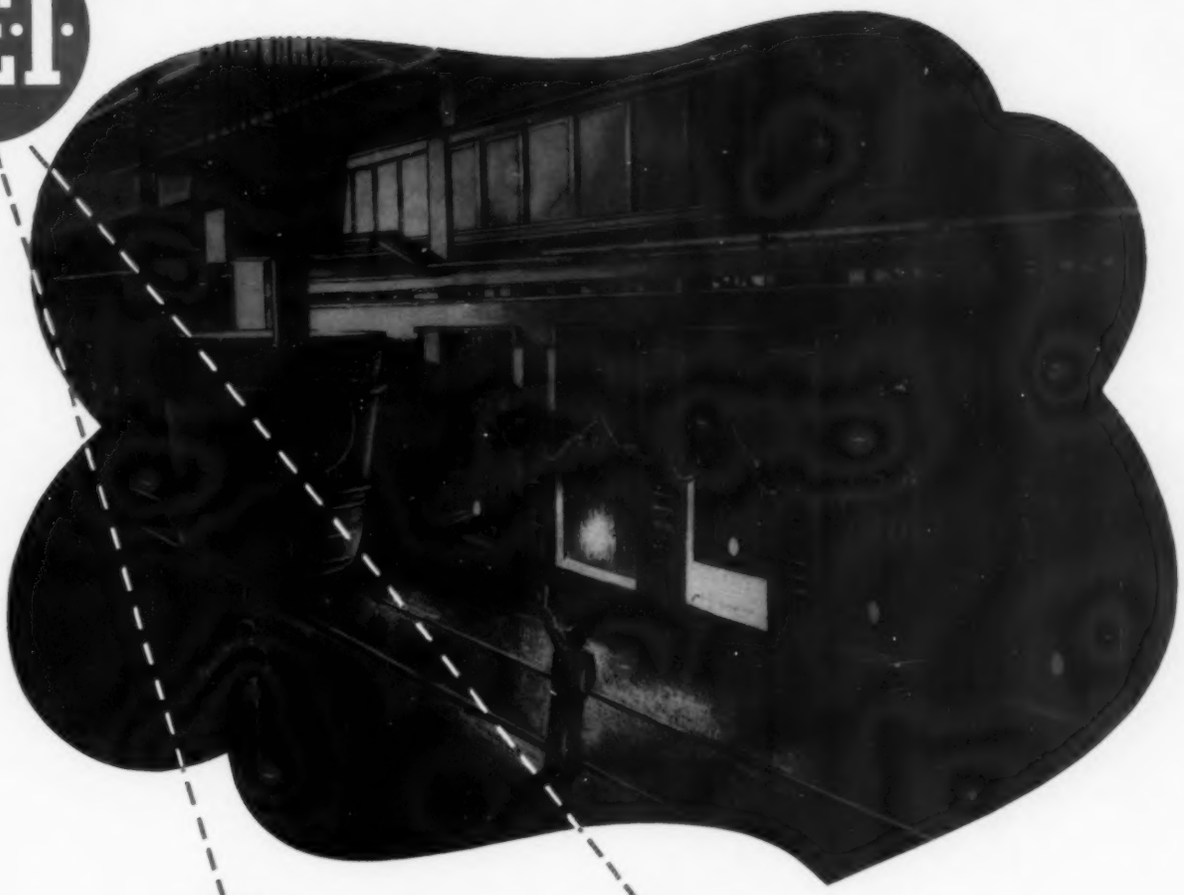
▲ Steam power capacity at the Midland, Pa., works of Crucible Steel Co. of America will be modernized and increased with the installation of two new boilers, according to Rust Engineering Co., the constructor. The project is expected to cost in the neighborhood of $1,225,000.

Six blast furnace-gas fired Rust

GOLDEN ANNIVERSARY

An interesting episode occurred at Elliott Co.'s 50th anniversary meeting of its veterans association. Company veterans, in costume of the times, reproduced the company's initial board of directors meeting, October 28, 1901, from actual minutes of the original meeting.

F·E·I·



FOR ENGINEERING IMPROVEMENTS *in* *Open Hearth* FURNACES

F. E. I. BUILDS

OPEN HEARTH FURNACES,
SOAKING PITS—*regenerative and one-way recuperative,*
CONTINUOUS REHEATING FURNACES *for slabs, billets and blooms,*
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ANNEALING and NORMALIZING *Furnaces for gun tubes, shells, bombs and armor plate,*
DIRECT FIRED BELL TYPE ANNEALING FURNACES *for coils, sheets and wire,*
GALVANIZING FURNACES *for tubes, sheets, metalware and jobbing,*
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Complete...from Plan to Production

Furnace Engineers, Inc. provides the latest advancements in Open Hearth Furnaces that insure top performance. Our staff includes men with up to 30 years or more experience . . . specialists in the design, construction and operation of all types of industrial furnaces.

F.E.I. service is complete—from plan to operation—whether it is an entirely new installation or the modernization of existing furnaces.

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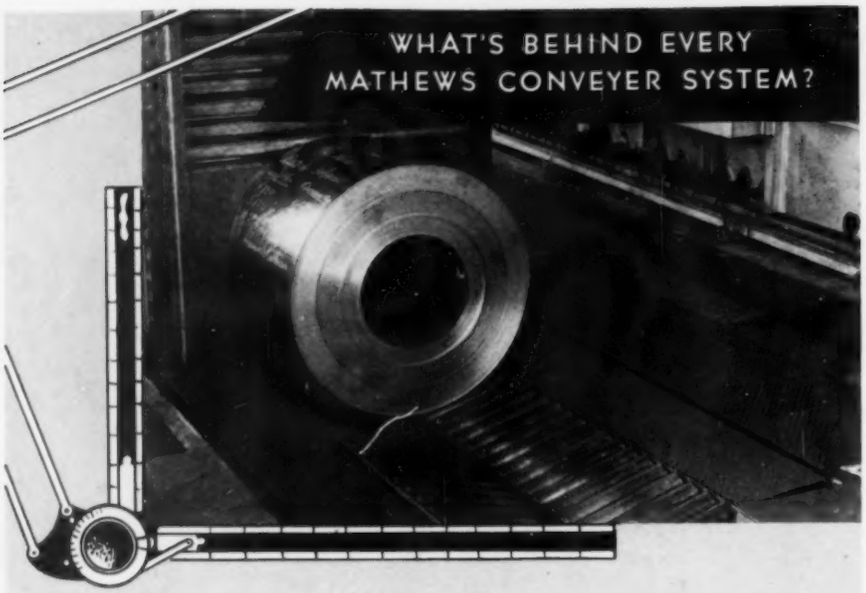
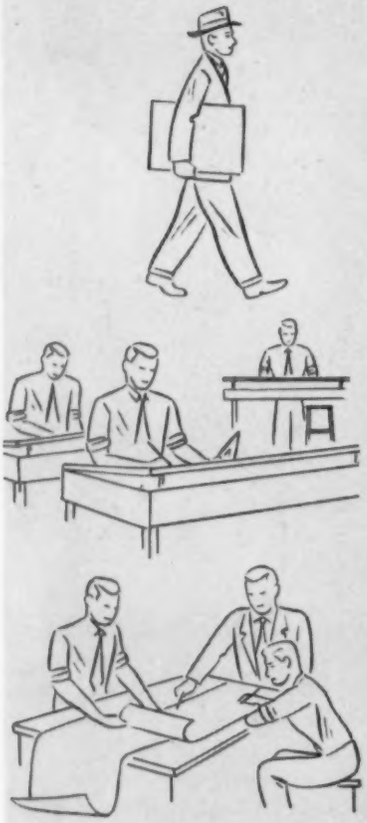
7

AFFILIATES—*Great Britain:* Salem Engineering Co., Ltd., Milford near Derby, England;
France, Belgium, Holland, Luxembourg and Italy: Heurtey & Co., 38 Av. G. Mandel, Paris XVI, France.



A BALANCED ENGINEERING STAFF



● No one can be all things to all people, and a conveyer engineer is no exception to this rule. In the large corps of Mathews Engineers, in the field offices and at the three plants, are many specialists in one or more of the various types of equipment we manufacture, and in the industries which we serve. Some are especially skilled in the design and application of Belt Conveyers. Others are specialists in the design of heavy conveying machinery. There are experts in foundry conveying problems, and those with special understanding of the design and application of Steel Mill conveyers. And so on. There are creative men, experienced detailers, and engineers specializing in the application of electrical and hydraulic equipment. It is indeed a balanced engineering staff. And, that's why we can say, "Whether a load weighs 1 pound or 50,000 pounds, it is a job for Mathews Engineers."

Engineering offices or sales agencies are located in principal American and Canadian cities.

MATHEWS CONVEYERS

GENERAL OFFICES . . . . . *Mathews Conveyer Company*
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CANADIAN DIVISION . . . . . *Mathews Conveyer Company, Ltd.*
PORT HOPE, ONTARIO

Engineering Offices or Sales Agencies in Principal American and Canadian Cities

boilers in use since 1905 are being removed to provide space for the new Babcock and Wilcox steam generators which will have a rated capacity of 75,000 lb per hour at 250 psi. They will be equipped to burn blast furnace gas with provisions for firing with pulverized coal or coke oven gas.

The new units will be housed in a new building addition being constructed at the No. 3 blast furnace boiler house. Existing ash handling and coal handling facilities, and feedwater lines will be extended to serve them.

The project includes installation of induced draft fans, and all boiler accessories, as well as construction of two new stub stacks and demolition of three old brick lined chimneys serving the original Rust boilers.

Construction is expected to be completed sometime in the spring of 1952.

WAPAKONETA ADDS TO MANUFACTURING CAPACITY

▲ New building construction will increase capacity of the Wapakoneta Machine Co., Wapakoneta, Ohio, by approximately 50 per cent. it was announced by M. Merle Harrod, vice president.

The new building, attached to the original plant, is of modern industrial design. It is built of brick and steel with continuous rows of leaded windows.

Mr. Harrod said "the very latest type of heat treating equipment, ma-

ENGINEERS RECEIVE KEYS

Three prominent engineers received gold keys as tokens of 50-year membership in The Franklin Institute at Philadelphia. Richard T. Nalle (far right), Institute president, presented the keys to (left to right) Gano Dunn, William E. Moore, and James M. Caird. Mr. Dunn is president of the J. G. White Engineering Corp. and an honorary life member of AISE. Mr. Moore, chairman of Pittsburgh Lectromelt Furnace Corp., is the inventor of the Rapid Lectromelt Furnace.

chining equipment and grinders will be included in this new facility."

"The heat treating equipment is of the latest design and type, with complete electric controls," he added. "Grinding will be with the latest type grinders, which will hold to a fraction of a thousandth of an inch."

The Wapakoneta firm, incorporated in 1891, is one of America's oldest and largest exclusive knife manufacturers. It is known throughout the country as one of the outstanding producers of straight, circular and irregular machine knives.

The present plant was rebuilt in 1944 after fire partially destroyed the original building.

NEW STEEL FIRM AT OWENSBORO, KENTUCKY

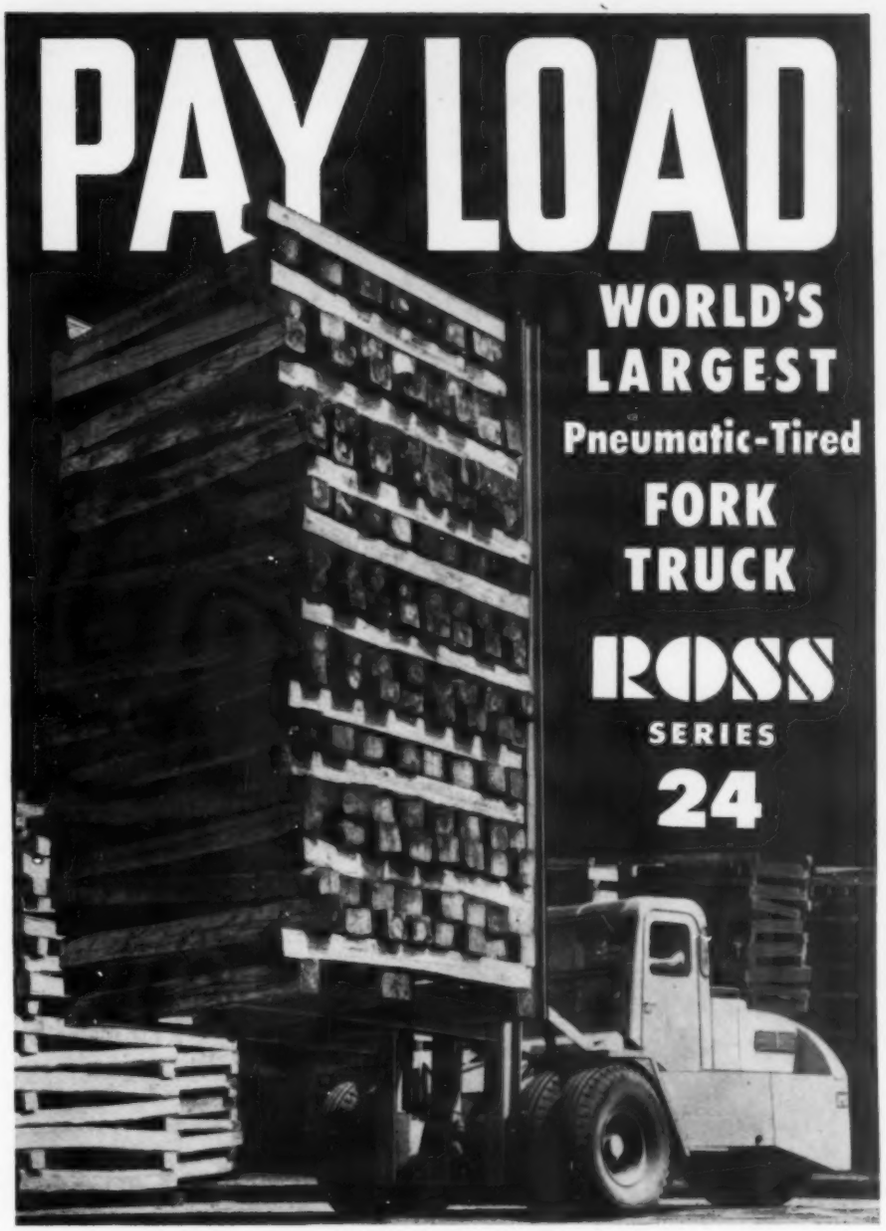
▲ The Green River Steel Corp. is a newly organized company and is currently engaged in constructing an electric furnace steel plant and rolling mill in Owensboro, Ky. Officers and principal employees are as follows: Sidney D. Williams, president; Robert B. Hensley, vice president; H. Grady Black, secretary and treasurer; Charles P. Hammond, general superintendent; and John E. Wolf, chief engineer.

CANADIAN FIRM TO SELL AIR FILTERS

▲ The Canadian business of the American Air Filter Co., Inc., Louisville, Ky. after January 1, 1952 will be handled by American Air Filter of Canada, Ltd., Montreal, P. Q. Mr. Wm. G. Hole, formerly of Darling Bros., Ltd. will be in charge of all Canadian operations. Representatives will be established in the larger Canadian cities to handle the AAF line of air filters, electronic precipitators and dust collectors.

GALVANIZING KETTLE IS INSTALLED IN 14 HOURS

▲ Halts in production are always exasperating and a thing like a leaking galvanizing kettle can be especially provoking. It always poses the problem—do we let it leak until a more favorable repair time and face the difficult job of digging frozen spelter from the setting and flues, or should the kettle be changed immediately with a current loss in production.



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SPEEDS HANDLING OF BILLETS, BARS, IN-PROCESS AND FINISHED MATERIALS

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HUGE 14.00-20 TIRES, PLENTY OF WEIGHT ON DRIVING WHEELS - MINIMUM YARD SURFACING REQUIRED

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TAKES TOUGHEST OPERATING CONDITIONS IN STRIDE

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You'll want full details on this giant fork truck . . . designed to further speed mass handling of heavy materials and reduce costs even more. Write today.

Rely On ROSS

THE ROSS CARRIER COMPANY

Direct Factory Branches and Distributors Throughout the World

400 Miller St., Benton Harbor, Michigan, U.S.A.

All plant craft men teamed together to make this 14 hour change in galvanizing kettles.

A recent kettle repair at the Etna, Pa., plant of Spang-Chalfant division of National Supply Co., shows what can be accomplished in reducing outage time when all plant craft men pull together. This teamwork recently relined a setting and installed a new kettle in the record time of 14 hours. Here is how it was done:

The leak started on July 28. The 90 tons of working metal were immediately pumped into molds containing chains. When the metal solidified, the molds were easily picked up by the crane and moved away. After the old kettle was removed, the setting was relined with brick and the new kettle installed on the 31st. From this point on the kettle was repacked with metal and melting down took place. On the morning of August 5 the kettle was again placed in production, on galvanizing pipe; all because every workman cooperated on the problem.

U. S. STEEL OPENS NEW RESEARCH LABORATORY

▲ A new laboratory for expanding the company's research in coal chemicals and coking processes has been opened by United States Steel Co. in the East End district of Pittsburgh, Pa.

Dr. E. C. Bain, vice president in charge of research and technology, said the laboratory at 6601 Hamilton Avenue will permit extended study in new uses for coal chemicals and in coking of coal for the steel industry. In coking research emphasis will be placed on the use of available coals in making metallurgical coke best suited to blast furnace requirements. Until now, only limited pilot plant scale experimentation on the subject has been possible in either the company's research and development center at 234 Atwood Street, or the Semple St. laboratory in the Oakland district.

Also in the new laboratory, one department is being set up for tests to aid in developing improved vitreous enameling steels, which are widely used in the manufacture of home appliances, and another for research on refractories used in iron and steel making furnaces.

The new laboratory will make available about 20,000 ft of additional floor space for the research work of U. S. Steel's Pittsburgh district scientists and engineers. Included will be chemical engineering laboratories, where pilot plants can be set up to make test runs and observation of many new chemical engineering developments to aid the men in the mills.

GE FORMS SIX NEW OPERATING DIVISIONS

▲ The formation of six new operating divisions has been announced by the General Electric Co.

The new divisions include the turbine division and the motor and generator division, both with head-

This valve is operated by the linear expansion and contraction of the three sets of tubes spaced around the rigid steel flange. When steam is passed through the tubes, thermal expansion frees the goggle plate. When the steam is removed, contraction closes the flanges against the goggle plate. Diameters of 36″ to 120″.

quarters at Schenectady, N. Y.; transformer and allied products division, with headquarters at Pittsfield, Mass.; measurements and industrial products division, with headquarters at Lynn, Mass.; switchgear and control division, with headquarters at Philadelphia, Pa.; and the component products division, with headquarters at Fort Wayne, Ind.

Together with the recently-announced defense products division, the six new divisions include the majority of the departments which constituted the former large apparatus division and small apparatus division.

GOVERNMENT APPEALS FOR MORE SCRAP

▲ Warning that the biggest threat to increased steel production is the shortage of scrap, the U. S. Department of the Interior has appealed to domestic mine and mill operators to do their part in seeing that all available scrap in their mines and plants will be sent to steel plants.

Sent to between 2500 and 3000 operators in the form of a memorandum, the appeal cites that the steel shortage, generally, is becoming so acute that in many cases there is not enough to fill even some authorized controlled materials orders.

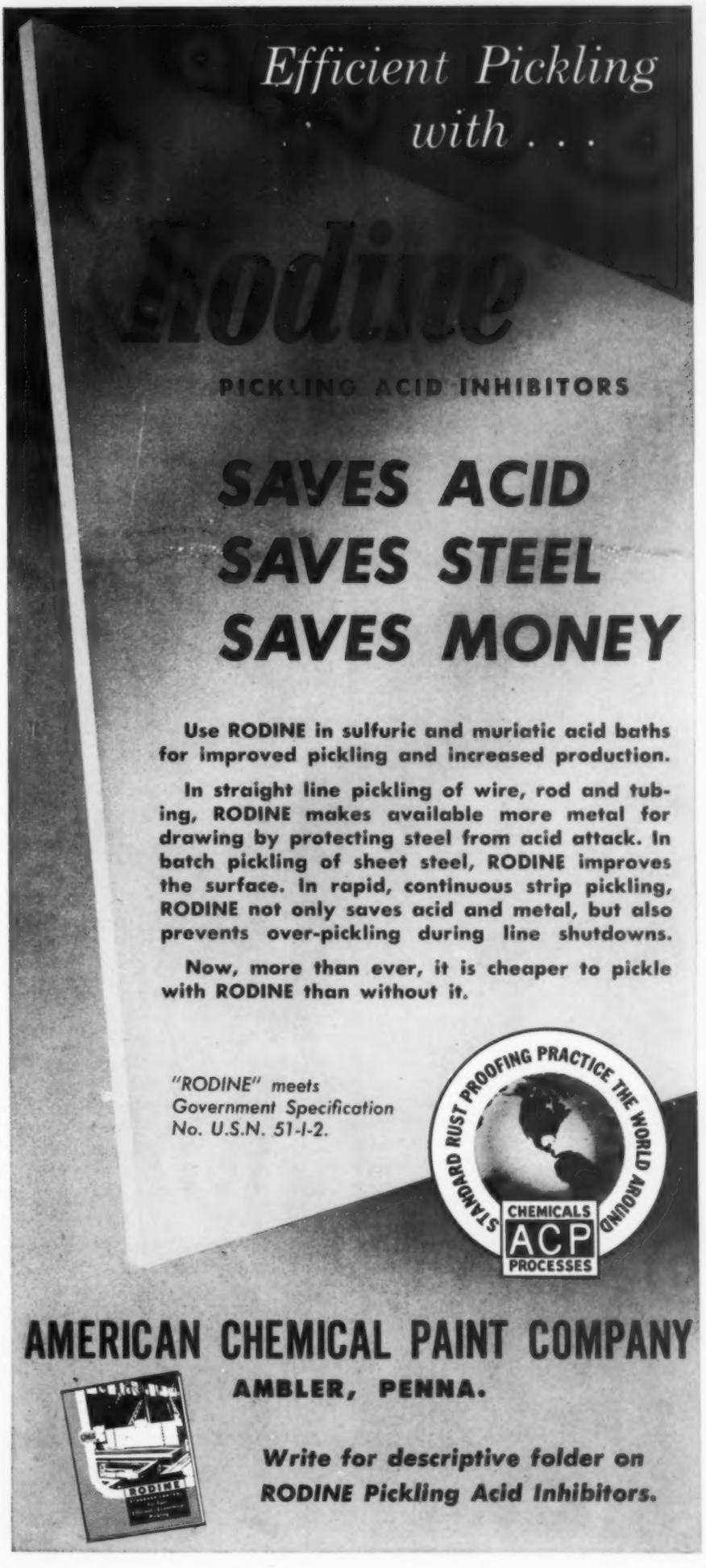
It is estimated that the steel industry will require 36,000,000 tons of scrap in 1951. Railroads, agriculture and coal operators already have made sizeable contributions to the scrap drive. Although steel scrap is most critical, copper, bronze, aluminum, brass and lead scrap are also in great demand.

CONVERT BLAST FURNACE TO HIGH TOP PRESSURE

▲ Cleveland No. 1 blast furnace of Republic Steel Corp. is back in production after a 38-day shutdown for relining and conversion to the revolutionary high top pressure technique.

As a result of the conversion, it is expected daily pig iron production of the furnace will increase from 1120 tons to 1260 tons. The entire job, which also included installation of new skip hoists, was completed in near-record time. The furnace was taken out of production September 22 and lighted again late Tuesday night, October 30.

It is estimated that some 25,000


Efficient Pickling with . . .
Rodine
PICKLING ACID INHIBITORS
SAVES ACID
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SAVES MONEY
Use RODINE in sulfuric and muriatic acid baths for improved pickling and increased production.
In straight line pickling of wire, rod and tubing, RODINE makes available more metal for drawing by protecting steel from acid attack. In batch pickling of sheet steel, RODINE improves the surface. In rapid, continuous strip pickling, RODINE not only saves acid and metal, but also prevents over-pickling during line shutdowns.
Now, more than ever, it is cheaper to pickle with RODINE than without it.
"RODINE" meets Government Specification No. U.S.N. 51-I-2.
STANDARD RUST PROOFING PRACTICE THE WORLD AROUND
CHEMICALS
ACP
PROCESSES
AMERICAN CHEMICAL PAINT COMPANY
AMBLER, PENNA.
RODINE
Write for descriptive folder on RODINE Pickling Acid Inhibitors.

tons of critically-needed pig iron was saved to the nation by speeding the "down" time to 38 days from the normal 60 to 75 days usually needed for such a job.

Cleveland No. 1 is the seventh of Republic's 21 blast furnaces throughout the country to be converted to the high top pressure technique. The application of "pressure blowing" to these seven furnaces results in an increase in production equivalent to the output of an additional furnace.

It was also announced that, for the third consecutive month, Cleveland No. 5 blast furnace of Republic Steel has established a new corporation blast furnace record. The furnace produced 50,215 tons during the 31 days of October. The previous record for the furnace was set during September, when 48,005 tons were produced during the 30 day month.

October production of the Cleveland furnace was at the rate of 1619 tons a day or 1.12 tons a minute. September output was at the rate of 1600 tons a day or 1.1 tons a minute.

The expected capacity of the furnace at the time of its construction in 1943 was 1250 tons a day. During the last year Republic has increased the hearth diameter from 27 to 28 ft. The furnace was the first in history to be operated by the revolutionary high top pressure technique to get greater production of critically needed pig iron.

MAGNESIUM USED TO PREVENT CORROSION

▲ There will be a minimum of underground corrosion of electrical lead sheathed cable, steel piping and structural steel to interfere with full-time production at U. S. Steel's new Fairless works at Morrisville, Pa.

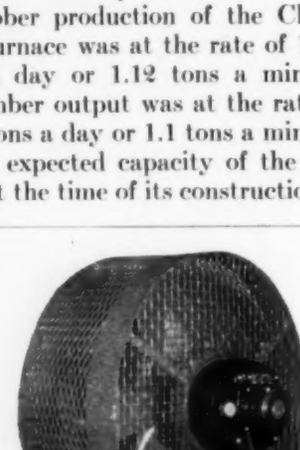
To protect these metallic installations, bars of magnesium metal will be tied in electrically with them and also will be buried adjacent to the big buildings in which steel will be made and shaped for the eastern market. This new cathodic protection was designed especially by the company's research engineers and engineers of the construction engineering bureau after careful measurements, at Morrisville and in U. S. Steel's research and development laboratory, of soil and water samples from the Fairless Works site.

Cable failures, burst pipes and weakened structures cause considerable damage to commercial and industrial installations each year. In an effort to prevent such corrosion losses at the new mill an exhaustive study was made of probable electrolytic action underground and at the foundation level.

It has been found that when dissimilar metals are in electrical contact and are placed in a conductive liquid or moist earth a natural electrical current is generated between the metals and flows from one to the other. This current flows from the metal which by its nature corrodes most to that metal which corrodes least, causing the less stable metal to disintegrate or "decay." This is the principle of electrolysis on which flashlight batteries operate and, in reverse, which makes electroplating possible.

About a hundred years ago Michael Faraday, a British chemist and physicist, discovered that the weight of an element displaced by electrolytic action is directly proportional to the intensity of the current, the length of time the current flows, and the electrochemical equivalent of that ele-

IS HEAT SLOWING UP YOUR WORKMEN?



TRUFLO CRANE CAB FANS
For cooling interiors of crane cabs and other confined areas. Adjustable both horizontally and vertically. Four blade type, 12 and 18 in. sizes.

Keep them COOL with TRUFLO FANS

TRUFLO PORTABLE COOLING FANS
Easily portable. Help keep efficiency high where work is hottest. 12 to 36 inch diameters.

Production suffers when workmen are overheated. Steps begin to drag, efficiency falls.

Now, when speedy production is vital, Truflo Fans can help keep your workmen on their toes. All Truflo Fans are designed and built correctly to put fresh cool air *in large volumes* exactly where it is needed. Perfectly-balanced shafts and blades give more air per h.p. . . . strong steel frames stand up longer under hard use . . . rugged wire guards protect men against injuries.

All of the following types can help beat the heat, keep production moving in your plant. Write for illustrated literature.

PORTABLE COOLING FANS
CRANE CAB FANS • WALL FANS
EXHAUST FANS • BLOWERS
ROOF VENTILATING FANS
PENT HOUSE FANS

TRUFLO FAN COMPANY
245 MAIN ST., HARMONY, PA.

ment. On the basis of Faraday's Law it was computed that one ampere of current in one year will dissolve 75 lb of lead. Similar displacement values were computed for the other metals.

Rods of the various metals which will be used in the underpinning and servicing of Fairless Works were inserted in a box of moist soil from Morrisville. These rods were connected to microammeters. The dial readings showed that lead and copper generate an initial current of about 50 microamperes, which slowly decreases to a somewhat lower reading, while steel and copper generate a current of about 30 microamperes, which slowly increases to a higher figure. In each case the flow of current through the soil was toward the copper, which acts as a cathode, or electrical positive, with consequent deterioration of the lead and steel, which become anodes, or negatives.

It has been known that if current from an external source could be made to flow in the reverse direction to the copper, lead and steel from a supplementary electrode, corrosion would be prevented.

In testing metals it has been discovered that magnesium is the most effective in setting up a current from itself to the lead, copper and steel. In laboratory terms, magnesium has the greatest "anodic potential." Small magnesium rods inserted in the sample of plant soil and connected to the copper rods reduced the readings of current between the other metals and the copper from as much as 50 microamperes to zero.

As a result of these studies, magnesium bars will be buried to effect cathodic protection of the underground installations at Fairless Works, and all copper and lead will be coated with a neoprene jacket. The rate of deterioration of the magnesium bars can be calculated by Faraday's Law and by physical and chemical factors present in the earth at Fairless Works. New bars of magnesium will be buried, as needed, to provide permanent, calculable protection against electrolytic corrosion.

MILBURN TO REPRESENT EAST ASIA TRADING CO.

▲ Toa Bussan Kaisha, Ltd., (East Asia Trading Co., Ltd.) of Tokyo, has named Loyal R. Milburn its agent for the importation into the United States of tantalum, titanium, thorium, columbium, selenium, cadmium, bismuth and other non-ferrous metals in wide use in this country. Mr. Milburn will carry on this business from his office at 1928 Guardian Bldg., Detroit 26, Mich.

KAISER MILLS SET NEW PRODUCTION RECORDS

▲ Kaiser Steel Corp., Fontana, Calif., produced a record 121,463 ingot tons of steel for October, operating its eight open hearth furnaces at 105.6 per cent of capacity. The previous high was 111,503 tons produced in September.

Mill loadings for the month of October also came to a high of 84,707 tons, made up of pipe, plate, structural shapes and other steel products.

The electric weld pipe mill produced medium sized pipe for oil lines and water pump manufacturers in the west resulting in a new high of 8021 tons. Output of this mill has increased from 3711 tons to the present 8021 tons in three months.

YALE & TOWNE SALVAGES NON-PRODUCTION SCRAP

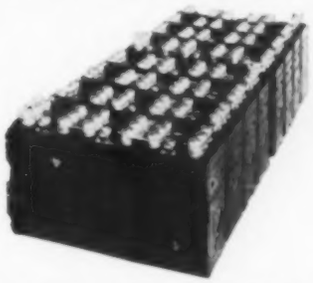
▲ More than 1,000,000 lb of non-production scrap metal has been salvaged for the country's defense production and returned to steel mills by Yale & Towne Manufacturing Co. this year. This is in addition to the thousands of tons of the usual "process scrap" consisting of chips and turnings.

Translated into terms of weapons for our armed forces, Yale & Towne's recovery of non-production scrap metal is the equivalent in weight of 107,012 bazookas or 13,376 fifty calibre heavy machine guns.

The salvage of 1,070,122 lb of scrap metal by Yale & Towne's five domestic divisions was initiated by the National Production Authority's recent request for a national scrap drive. Non-production metal scrap recovered by Yale & Towne consisted mainly of worn out or obsolete tools, dies, jigs, fixtures, machinery, sinks, metal partitions, and cast iron pipes.

USE THE
ENGINEERING MART

NICAD
MADE IN U.S.A.
T-TYPE BATTERY
for
RAILROAD
DIESEL STARTING
2 models—THR-30, THR-44



SAVES UP TO 100 MAN HOURS PER YEAR PER LOCOMOTIVE

Because the NICAD nickel cadmium storage battery requires less maintenance you save precious man hours and, at the same time, are assured of reliable, foolproof battery service throughout its long life. The T-Type NICAD battery has an exceptionally high ampere rate of discharge at useful voltage, a vital consideration in engine-starting applications.

BATTERY TYPE	AMPERE HOURS	NUMBER OF CELLS	GROUP TRAY LENGTH A	TRAY WIDTH B	WEIGHT LBS.
THR 30	142	48	33¾"	8"	1825
THR 44	210	48	44⅝"	11"	2673

THR-30—Interchangeable with 17-plate, 248 A.H. Lead Acid Batteries
THR-44—Interchangeable with 25-plate, 426 A.H. Lead Acid Batteries

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Exceptionally Long Life
Low Cost Operation
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Rugged Steel Construction
Very Low Self-Discharge
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MADE EXCLUSIVELY IN THE U.S.A.

Pickling tank and wash tank at Laclede Steel Company. Note the rolls fabricated from tough corrosion- and wear-resistant Ampco Metal. Roll dimensions 31" OD x 29" ID x 36" long. Side plates 34½" OD x ½" thick with 5" ID for shaft.

Here's another roll used at Laclede. Fabricated from money-saving Ampco Metal, it handles six strips at a time.

Laclede Steel
fights wear and corrosion in its pickling line with
AMPCO METAL*

. . . keeps production up . . . costs down

Steel companies throughout the country are faced with terrific production problems. Laclede Steel Company, St. Louis, like so many others, found one answer in Ampco Metal.

Shown here is their pickling operation. The tank carries a 12% sulphuric acid solution at 200°F. The strip enters the tank and goes through the entire process via wear- and corrosion-resistant Ampco Metal rollers.

The rollers and side plates are fabricated from Ampco Grade 8 plate. Shafts and nuts are made from extruded Ampco Grade 15.

But resistance to corrosion in pickling service isn't the only important feature of Ampco Metal. It also resists wear, shock, impact. That's why so many mills use Ampco Metal screw-down nuts, slippers, wear plates, flash-welder dies.

If you have a corrosion problem or a wear problem, it pays to investigate the advantages of Ampco Metal. See your nearby Ampco field engineer or write us for details.

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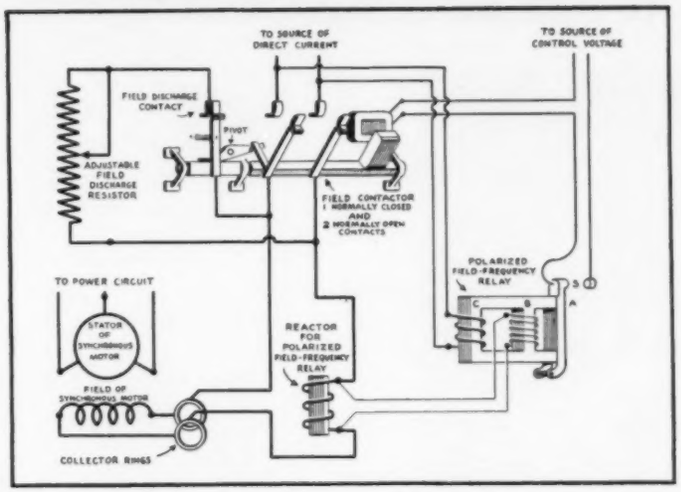
G-11

EC&M SYNCHRONOUS STARTERS

with Automatic Field Application by Polarized Field-Frequency Relay


TO SOURCE OF DIRECT CURRENT
TO SOURCE OF CONTROL VOLTAGE
FIELD DISCHARGE CONTACT
PIVOT
ADJUSTABLE FIELD DISCHARGE RESISTOR
FIELD CONTACTOR 1 NORMALLY CLOSED AND 2 NORMALLY OPEN CONTACTS
POLARIZED FIELD-FREQUENCY RELAY
TO POWER CIRCUIT
STATOR OF SYNCHRONOUS MOTOR
REACTOR FOR POLARIZED FIELD-FREQUENCY RELAY
FIELD OF SYNCHRONOUS MOTOR
COLLECTOR RINGS

Push Button Start **brings motor up to speed automatically. Motor pulls into step *without delay*. Automatic Field Removal if motor slows down on voltage dips or overload. Field automatically re-applied when load re-accelerates.**

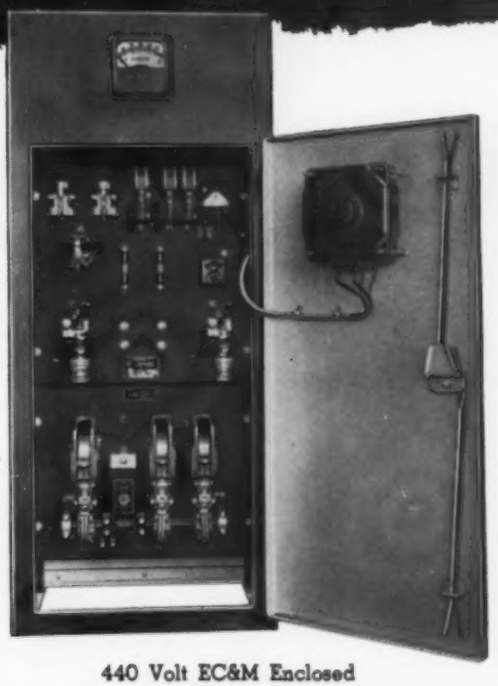
★★★

With greater skill than human hands could do it, EC&M Push Button Magnetic Starters provide completely automatic operation of synchronous motors.

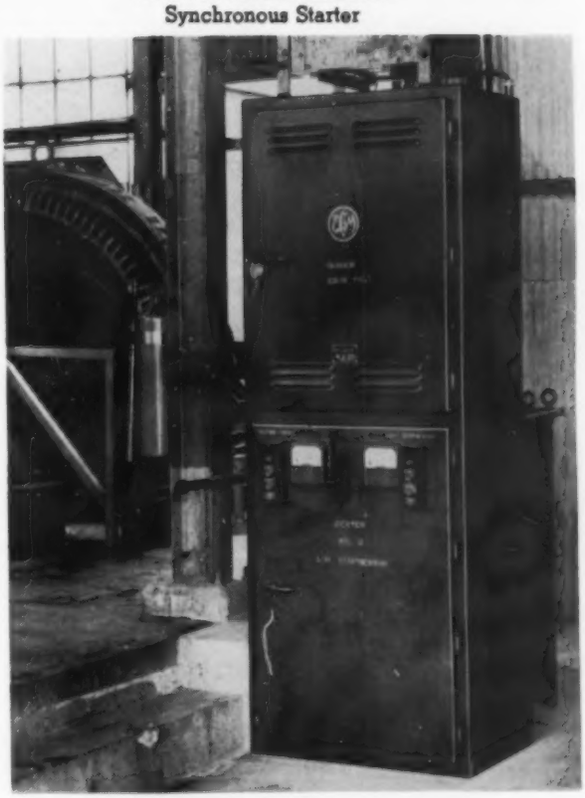
At about 95% synchronous speed, the motor is pulled into synchronism. Full Field excitation occurs when the rotor and stator poles are most favorable to locking into synchronism. This causes synchronization to occur without pole slippage, with minimum line current and greatest synchronizing torque.

EC&M Synchronous Starters are built for both low and high voltages up to 4600 volts. They are of unit construction with all internal wiring complete. The cubicle types are totally enclosed and do not require an expensive control room. They may be mounted alongside the motors they control.

Write for No. 21 ACCELERATOR and Bulletins 1075, 1076, 1077 and 1078



440 Volt EC&M Enclosed Synchronous Starter



2300 Volt EC&M VALIMITOR Starter for Steel Mill Air Compressor

THE ELECTRIC CONTROLLER & MFG. CO.

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WHEREVER THE HOT STUFF HITS

USE NATIONAL CARBON

TRADE-MARK

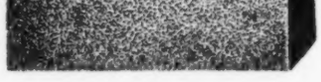
For the cinder notch liner!

For the cinder notch plug!

For the splash plate!

For the runout troughs!

For the skimmer plate!



● "National" carbon is now firmly established for blast furnace linings. It is being used outside the furnace as well—wherever there is contact with molten material—for the splash plate, runout troughs—clear down to the ladle—skimmer plate, cinder notch liner and cinder notch plug.

The reasons?

"National" carbon has no melting point. It is highly resistant to slag attack and thermal shock . . . not wet by molten metal . . . has a low thermal expansion . . . and maintains its mechanical strength at elevated temperatures.

Use "National" carbon inside and outside your blast furnaces and you cut down maintenance, speed up production and save money. For more information, write to National Carbon Company, Dept. E

The term "National" is a registered trade-mark of Union Carbide and Carbon Corporation

NATIONAL CARBON COMPANY

A Division of Union Carbide and Carbon Corporation

30 East 42nd Street, New York 17, N. Y.

District Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

IN CANADA: National Carbon Limited
Montreal, Toronto, Winnipeg

Personnel News...

Henry A. Denny was named production manager, Engineering and Construction division of Koppers Co., Inc. Mr. Denny, who has been assistant production manager, succeeds Frank Chambers, who has resigned.

Philip Ryan has been appointed executive vice president of Cutler-Hammer, Inc., Milwaukee, Wisc., in addition to his duties as vice president in charge of manufacturing, a position he has held for the past six years. **R. A. Millermaster** has been appointed manager of the development department. For the past five years he has been assistant manager of the development department. **C. W. Kuhn** has been appointed director of development engineering for the company. Since 1946 he has been assistant manager of that department.

Four employees of Allegheny-Ludlum Steel Corp., Pittsburgh, Pa., were presented with the Allegheny-Ludlum Award in recognition of their outstanding achievements on behalf of the company.

The awards, which include a citation from the board of directors, "The President's Medal," and $1000 in cash, were presented to **Schuyler A. Herres,** associate director of research with headquarters at the Watervliet, N. Y., plant; **Douglas S. Gormly,** assistant chief metallurgist at the Dunkirk, N. Y., plant, and **I. G. Shoff** and **John Eagleson,** manager and assistant manager of the hot mill department of the West Leechburg, Pa., plant. The latter two men won their award jointly. The awards were presented by E. J. Hanley, company president, at a luncheon in honor of the employees tendered by the board of directors.

R. D. Johnson, formerly general manager of the Ellwood City, Pa., and Warren, Ohio, plants of Aetna-Standard Engineering Co., has been named assistant to vice president H. G. Coffey. He will be succeeded as general manager at Ellwood City by **T. C. Ben. Lawrence R. Jeffers** takes over as general superintendent of Ellwood City plant, with **W. E. Durstine** as assistant. **James H. Rauch** has been appointed superintendent of roll department and **Robert R. Kelly** has been named office and traffic manager of the Ellwood City plant.

Joe M. Deal was named works auditor at Gary, Ind., works of United States Steel Co. Mr. Deal had been assistant works auditor at Irvin works, Dravosburg, Pa.

George C. Floyd was elected vice president of Vanadium Corp. of America. Since 1947 Mr. Floyd has been vice president of Thomas Steel Co.

James N. Imel has been advanced, at Pittsburgh, Pa., Works, Jones & Laughlin Steel Corp., from assistant superintendent of sheet and strip department to superintendent of that department.

Dr. Walter Mathesius, president of Geneva Steel Co., who has announced his retirement from that position, will become a consultant for the Freyn Engineering department of Koppers Co., Inc.

Maurice S. Kelly has joined Crucible Steel Co. of America as editor of the company's employee newspaper scheduled to start publication early in 1952. Mr. Kelly formerly was publicity manager of National Electric Products Corp., Pittsburgh, Pa.

John Bidner was appointed assistant to the general superintendent, Sharon Steel Corp., Sharon, Pa. Mr. Bidner will be responsible for the coordination of melting practice in the company's two steel plants and for the effective use of raw materials required in these operations. He was formerly open hearth superintendent at the company's Roemer Works. Replacing Mr. Bidner as open hearth superintendent will be **Francis J. Herman.** Mr. Herman was formerly assistant open hearth superintendent. **Raymond C. Oswald,** relief foreman at Sharon Steel's Lowellville Works becomes the assistant open hearth superintendent at the Roemer Works in Farrell.

Frank F. Cambest, former assistant general superintendent, has been appointed works manager of the Pittsburgh, Pa., Works division of the Jones & Laughlin Steel Corp., John B. Mitchell, vice president-operations, has announced. At the same time, Mr. Mitchell announced changes in executive titles and plant identifica-

HENRY A. DENNY

PHILIP RYAN

R. A. MILLERMASTER

C. W. KUHN

tion affecting the corporation's three steel works. The J&L plants in Pittsburgh, Aliquippa, and Cleveland will be known as the Pittsburgh Works division, the Aliquippa Works division, and the Otis Works division. The title of "general superintendent" of the three works has been changed to "works manager." **L. A. Lambing,** former general superintendent of the Pittsburgh Works division, has been appointed specialist-steelmaking on the staff of the vice president-operations. **H. H. Shakely,** former superintendent of the strip sheet department at Pittsburgh works, becomes assistant works manager.

Frank W. Chambers was appointed to the executive staff of Kennecott Copper Corp. as director of engineering. Associated with the Koppers Co. for many years, Mr. Chambers served on the steel plant expansion committee of the Office of Production Management prior to United States entry into World War II. He was project manager of the Butadiene-Styrene plant built in 1943 at Kobuta, Pa., for the production of synthetic rubber stock. Thereafter, he served two and a half years in the U. S. Navy. After returning to civilian life, Mr. Chambers spent 18 months in Chile, supervising the organization and construction of the first integrated steel plant on the West Coast of South America. Since January 1949, he has been production manager of the Engineering and Construction division of Koppers Co.

Eugene W. Phillips was named manager of construction of the seamless tube installation project at the Chicago, Ill., district of Republic Steel Corp. Upon completion of his Chicago assignment, Mr. Phillips will

EUGENE W. PHILLIPS

return to his position of chief engineer at Republic's Central Alloy district in Canton and Massillon, Ohio. During Mr. Phillips' Chicago assignment **Oscar M. Schulze** will serve as acting chief engineer of Republic's Central Alloy district.

Meet today's increased tonnage demands with

Custom Engineered

FURNACES by Grant Watson

Battery of six ingot heating furnaces. One of many individually engineered installations designed, built and installed complete by Grant Watson. Each furnace capable of holding six steel ingots 24-in. square by 81-in. long.

Designers of individually engineered heating and heat treating furnaces, both gas and oil fired, for reheating slabs, billets, rods, bars and blooms; forging; soaking pits; annealing and normalizing; stress relief; and other industrial heating applications.

Grant Watson "Custom Engineered" furnaces deliver maximum heating efficiency, uniform product quality, positive temperature control plus the versatility and flexibility that pays off in increased tonnage and economical operation. Regular COST-FREE SERVICE after installation reduces maintenance costs, assures trouble-free performance day-in and day-out.

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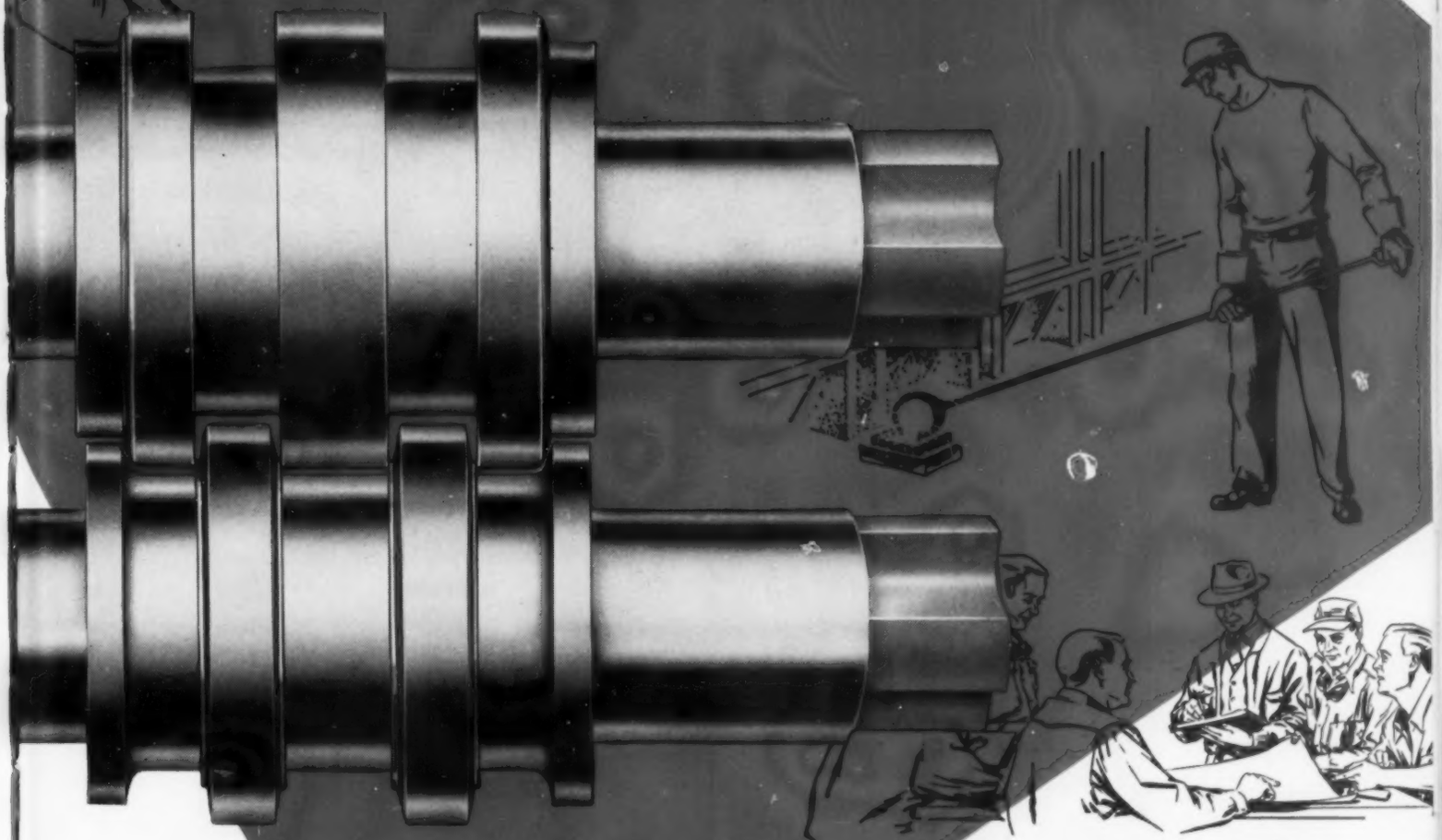
Ohio Rolls

SHAPING METAL FOR ALL INDUSTRY



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Select from any of these eleven types of Ohio Steel and Iron Rolls:

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Chilled Iron Rolls
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Every step of the way through production, the quality of your rolls is insured by the group talent of Ohio Steel's PROCESS CONTROL unit. They take over when your order is received. In every phase of manufacture, the same group of metallurgists, chemists, engineers and inspectors follows the progress of your order. They know what has gone before and what remains to be done. Under their direction your rolls are made. And the result is as close to perfection as is possible.

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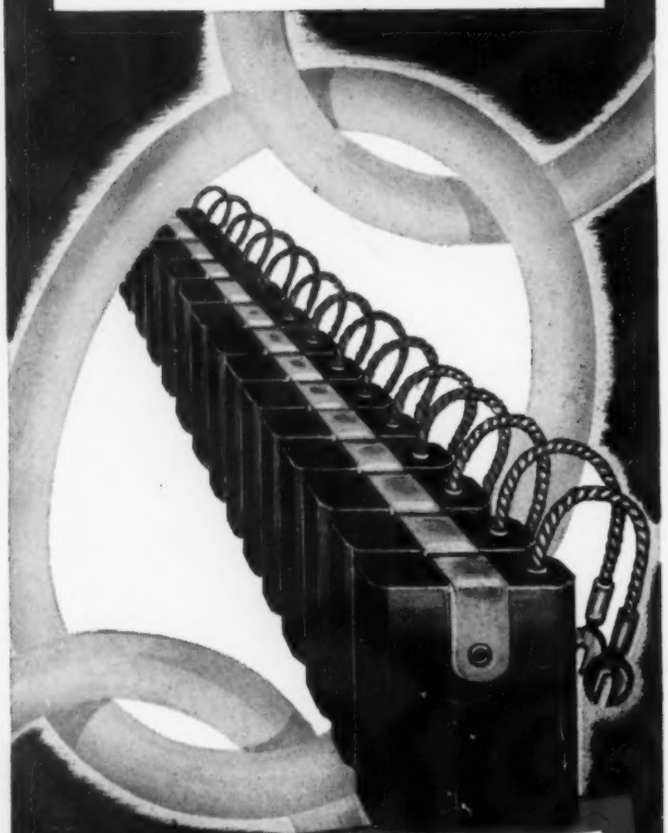
PLANTS AT LIMA AND SPRINGFIELD, OHIO

Link YOUR COMMUTATION TO THE RIGHT
MORGANITE
brush grade



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CARBON BRUSHES

The wide range of MORGANITE brush compositions is an important aid when selecting a brush to meet a specific motor or generator operating condition. Equally helpful is the wide experience of MORGANITE engineers who will gladly assist in determining your proper brush grade.

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INCORPORATED
LONG ISLAND CITY 1, NEW YORK

Manufacturers of Morganite Self-Lubricating Carbon Specialties including Seals, Rings, Valves, Slides, Bearings, etc., and Carbon Piles

William M. Black was appointed president, and **Joseph L. Mullin** vice president, of Electro-Alloys division, American Brake Shoe Co. **Walter G. Hoffman,** formerly president of Electro-Alloys division was appointed assistant to the vice president for research and development of American Brake Shoe.

A. C. Polk, Jr., assistant manager of Dowell, Inc., Tulsa, Okla., has been named general manager. The promotion is effective immediately.

William H. Myers has been named as general district superintendent in charge of six plants of Harbison-

WILLIAM H. MYERS

Walker Refractories Co., and **J. H. Moore, Jr.** was appointed general district superintendent in charge of coke oven manufacture. **Charles W. Ayers** has been appointed superintendent of the company's new Wind-

J. H. MOORE, JR.

ham, Ohio silica plant, and **William N. Bartleson** will be superintendent of the newly acquired plant at Warm Springs, Calif.

Harold E. Erf, representative in northeastern Illinois for The Sterling Grinding Wheel Division, has been appointed sales executive–administration. Mr. Erf will be located at the home office in Tiffin, Ohio. **John Andreas** and **Edward Kass** have been appointed sales representatives, with headquarters in the company's district office, at 1814-16 South Michigan Avenue, Chicago, Ill.

the drive that has everything

compactness

large load capacity

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delivery out of stock

modern design

high quality precision gearing

Foote Bros. Line-O-Power Enclosed Gear Drives offer industry compact, straight-line units with efficiencies of 96% or higher.

Duti-Rated high hardness precision gears are assembled into streamlined housings of rugged cast iron.

Economical in original cost because the latest, most accurate high production machine tools assure rapid production with exceptional accuracy for long wear life. Economical to operate because simplified construction, minimum number of moving parts, direct splash lubrication, quality workmanship all hold maintenance to a minimum.

Line-O-Power Drives are available for delivery from stock in double or triple reductions for capacities from 1 to 200 h.p., with ratios from 5 to 1 up to 238 to 1

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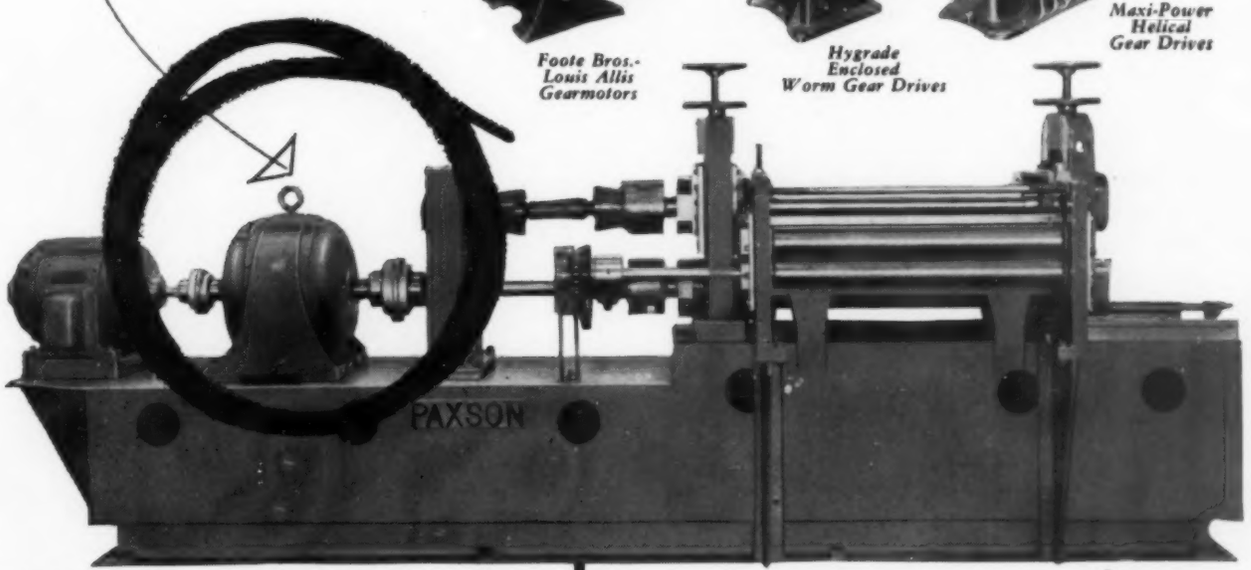

Standard 36-inch slitter, manufactured by Paxson Machine Co., Salem, Ohio

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Better Power Transmission Through Better Gears

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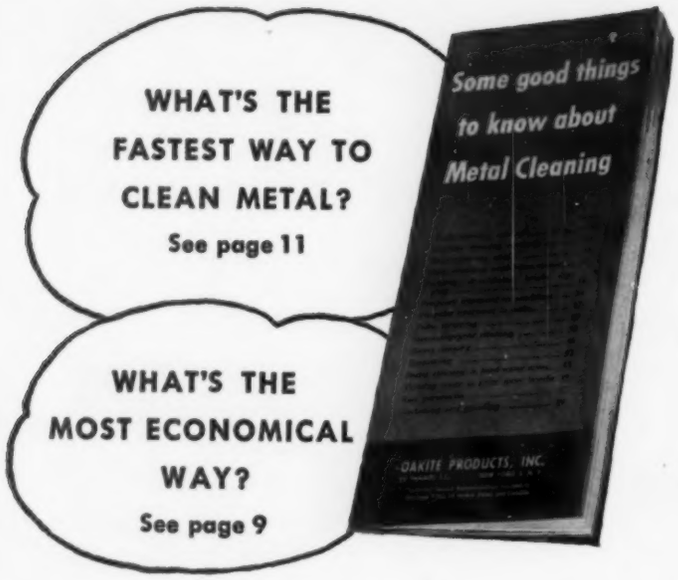
WHAT'S THE FASTEST WAY TO CLEAN METAL?
See page 11
WHAT'S THE MOST ECONOMICAL WAY?
See page 9
Some good things to know about Metal Cleaning
OAKITE PRODUCTS, INC.

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"Some good things to know about Metal Cleaning"

answers many questions that mean better production for you, more money in your pocket. You'll want to read more about:

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What kind of cleaner attracts both oil and water? How does this help remove buffing compound residues and pigmented drawing compounds? *See page 8.*

What are the advantages of reverse current for electrocleaning steel? *See page 15.*

For nonferrous metals, what are relative advantages of cathodic, cathodic-anodic and soak-anodic cleaning? *See page 17.*

Can you electroclean brass without tarnishing? *See page 18.*

Would you like a cleaner that removes rust and oil in one operation, often eliminating all need for pickling? *See page 28.*

Does your burnishing produce a luster you are proud of? *See page 32.*

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Technical Service Representatives in Principal Cities of U. S. & Canada

Charles J. Paumier was appointed Pacific Coast representative for Electric Furnace Co., Salem, Ohio. Mr. Paumier, who was formerly connected with Revere Copper & Brass Co., has opened offices in the Bank of America Bldg., 908 Atlantic Blvd., Los Angeles, Calif.

Announcement is made by Mr. G. S. Crane, president, Cutler-Hammer, Inc., Milwaukee, Wisc., nationally-known manufacturers of motor control, of a number of important organizational appointments.

Edwin B. Palmer formerly salesman for the Westinghouse Electric Corp., Pittsburgh, Pa., is now sales engineer for the Herr-Harris Co., 545 Wm. Penn Place, Pittsburgh, Pa.

Edwin W. Sankey was elected vice president and assistant to the president for Baker-Raulang Co. **John**

EDWIN W. SANKEY

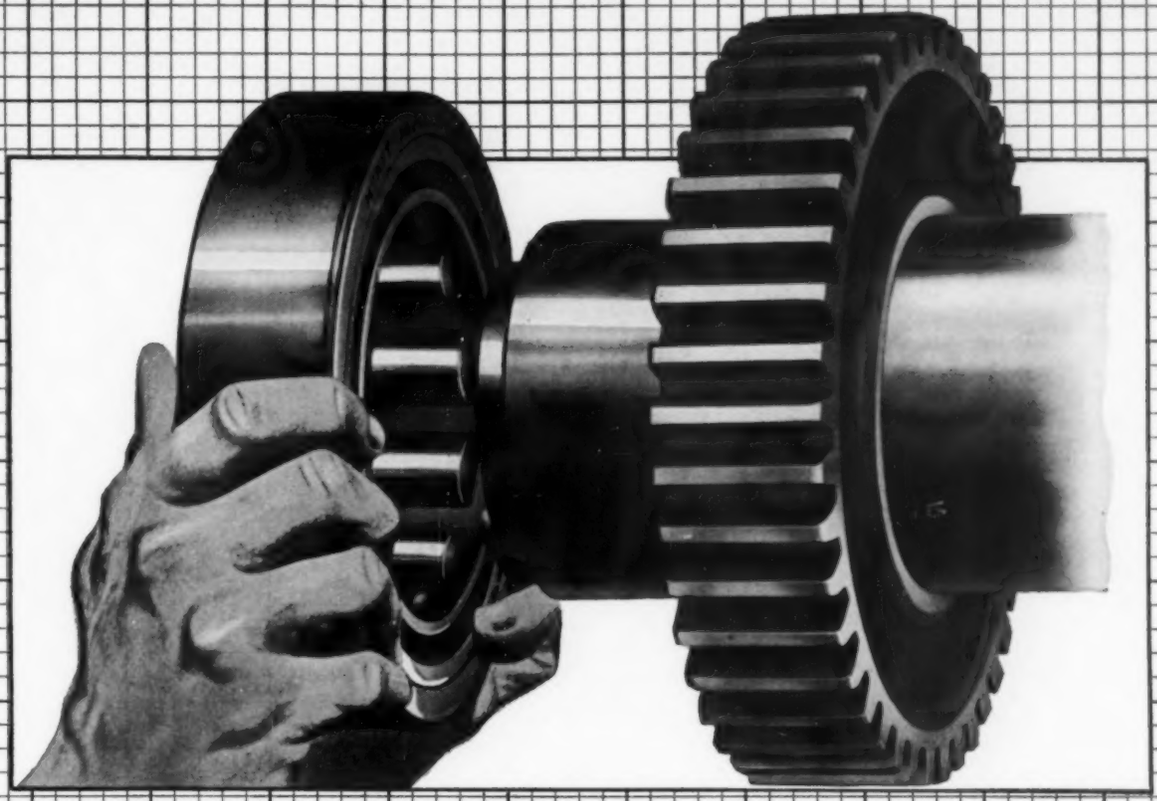
A. Matousek was elected vice president in charge of manufacturing.

J. A. MATOUSEK

John Drollinger, Jr. has been appointed manager of the newly opened branch office of Reliance Electric and Engineering Co. at Toledo, Ohio.

James Norman has joined the staff of Senior, Juengling and Knall in their Birmingham, Ala., headquarters.

William W. Timmis, Jr. was appointed southern sales and service manager for Dravo Corp.'s heating department. Mr. Timmis will supervise the activities



When Hyatts Go In —Bearing Wear and Care Go Out

Providing maximum load carrying capacity in a given space, unusual ability to withstand sudden shocks or abnormal temperatures, and permitting axial shaft expansion without binding... no wonder bearing wear and care go out when Hyatts go in.

Cars, cranes, tables, mill motors, and other auxiliary equipment last longer, run smoother, and require less maintenance with the application of these better Hyatt Roller Bearings.

Aware of this, equipment builders regularly design in Hyatts, and mill men make a practice of specifying them for tough jobs or using them as changeovers.

* * *

At convenient locations, there are Hyatt steel mill bearing men to serve you. Hyatt Bearings Division, General Motors Corporation, Harrison, N. J., Pittsburgh, Chicago, and Oakland, Calif.

HYATT ROLLER BEARINGS

LINTERN
AIRE-RECTIFIERS
THE ORIGINAL SPLIT SYSTEM
The Choice of those Who Know

■ Following is a partial list of users of Lintern Aire-Rectifiers. Without exception, the original installation has been followed by repeat orders.

We value highly the confidence thus expressed in our product.

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Cleveland, O., Tennessee, Texas and Davenport, Iowa Plants
American Steel & Wire Company
Atlantic Steel Company
Bethlehem Steel Corporation
Bethlehem, Lackawanna, Steelton, Sparrows Point and Johnstown
Birmingham Slag Company
Canadian Carborundum Company
Colorado Fuel & Iron Company
Columbia Steel Company
Dominion Steel Foundries Ltd.
Electro-Metallurgical Company
Ford Motor Company
Detroit and Canadian Plants
Geneva Steel Company
Great Lakes Steel Corporation
Inland Steel Company
Jones & Laughlin Steel Corporation
Kaiser Steel Corporation
Kennecott Copper Company
Keystone Steel & Wire Company
Laclede Steel Company
McClouth Steel Corporation
National Tube Company
Lorain, Gary and McKeesport Works
Newmont Mining Company
Newport Steel Corporation
Northwestern Steel & Wire Company
Page Hershey Tubes Ltd.
Pittsburgh Metallurgical Company
Pittsburgh Plate Glass Company
(Columbia Cement Division)
Republic Steel Corporation — *Cleveland*
Reynolds Alloy Corporation
Rotary Electric Steel Company
Standard Steel Spring Company
Southern Acid and Sulphur Company
Stanley Works,
American Tube and Stamping Plant
St. Lawrence Alloys Company Ltd.
Timken Roller Bearing Company
U. S. Navy
U. S. Steel Company
Ohio, Gary, South, MacDonald and Fairless Works
Weirton Steel Company
Westinghouse Electric Company
West Virginia Pulp & Paper Company
Wheeling Steel Company
Wisconsin Steel Company
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Indiana Harbor

Lintern Aire-Rectifiers have been installed also on cranes for England, France, South Africa, and Chile.

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29-2 RIVERSIDE DRIVE • BEREA, OHIO

of this department in the Southern territory, with headquarters at 800 Peachtree Street, N.E., Atlanta, Ga.

L. C. Barton, manager of the Wagner Electric Corp.'s electrical division branch office in Atlanta, Ga. retired recently. **W. H. Prewitt, Jr.** has been named to succeed Mr. Barton.

Warren Erbe has been transferred from the Cincinnati, Ohio, office of Electric Service Manufacturing Co. to the St. Louis, Mo., office where he will work with **Thomas McKenna** who has been in the latter area for many years.

Harry H. Yeager was named general superintendent of plant operations for Harbison-Walker Refractories Co. Mr. Yeager has been associated with Harbison-Walker, in the operating department, since 1905, and served until recently as general district superintendent, with headquarters in Pittsburgh. He also is past superintendent of various plants in the Clearfield, Pa., district.

Obituaries

W. Bruce Ogden, 58, vice president of Valley Mould and Iron Co., Hubbard, Ohio, died recently.

Robert N. Blakeslee, 58, vice president and director of engineering of Ajax Electrothermic Corp., Trenton, N. J., died suddenly on October 17, 1951. Mr. Blakeslee had been associated with Ajax Electrothermic for 24 years.

Dr. E. F. Foss, director and chief metallurgist for the Wheeling Steel Corp., died recently in Santa Barbara, Calif.

F. J. Griffiths, 73, one of the founders of Central Steel Co., now a part of Republic Steel Corp., died November 23. Mr. Griffiths rose to president of Central Steel Co. and after its merger with United Alloy Steel Corp. in 1926, he became chairman of the board. He later served with Republic Steel Corp., Steel and Tube division of Timken Roller Bearing Co., and Copperweld Steel Co. He was a director of a number of other companies.

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CEMENTS FLOORS LININGS COATINGS
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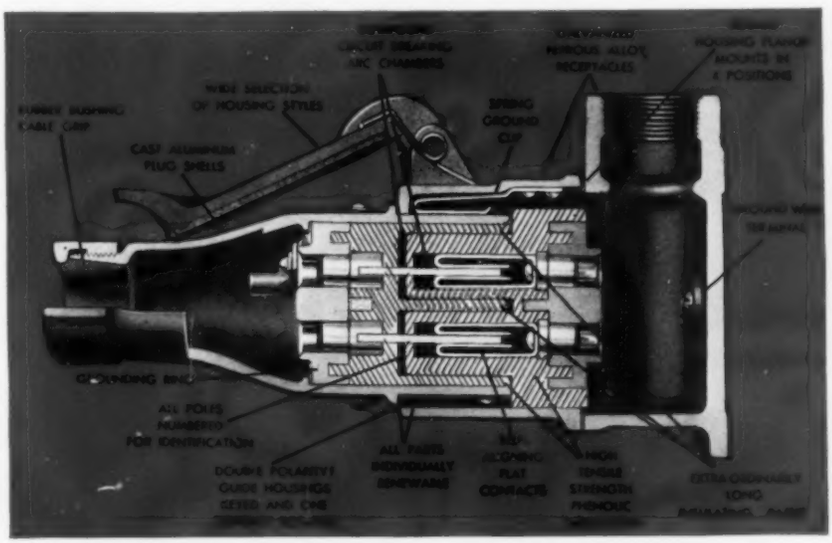
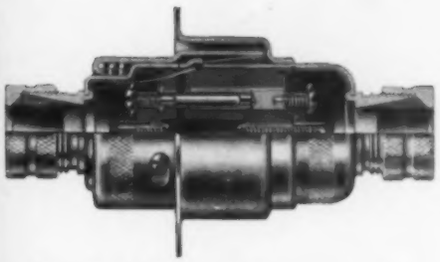
Heavy Duty Plugs and Receptacles

FOR PORTABLE ELECTRICAL EQUIPMENT

Pyle-National plugs and receptacles are built to withstand the most severe operating conditions, as proven by years of remarkably dependable service in a wide variety of industrial applications. The many substantial construction features of this extensive line of plugs and receptacles and the high quality of materials and workmanship insure safe operation, uninterrupted service and long life.



QuelArc* • ***Circuit Breaking Series*** **Unique partitioned insulation provides long insulated paths through air and across surfaces for exceptional protection in these current rupturing devices. Cast metal housings, high grade insulation and individually renewable contacts insure long service life. Ratings 20, 30, 60, 100 and 200 amperes, 250 volts DC, 600 volts AC—2, 3, and 4 pole—grounded through shell or extra pole. Threaded cap, plain and hinged spring door housing styles are available.**



Interchangeable reversible contact units. 1, 2, 3, 4, 6, 8 pole

Triploc* ***and Multiple-Circuit Series***

A line of exceptional versatility, unequalled in the heavy duty field, with a virtually unlimited number of assembly combinations for varied applications. Offers a selection of 1, 2, 3, 4, 6 and 8 pole contact units which are interchangeable and reversible in any single set of housings. Many types of housings available of pressed steel with automatic lock and of cast metal threaded for watertight gasket seal. Multi-Circuit housings with 2, 3 and 4 contact units available for combinations up to 32 poles. Ratings 15 and 20 amperes, 250 volts DC, 460 volts AC—circuit breaking. Pressed steel fusible and fuseless plugs measure only 1 13/16" outside diameter.

Midget Triploc* ***Series*** **Same construction features as Triploc except for much smaller outside diameter of plug shell—only 1¼". Interchangeable and reversible contact units—2, 3 and 4 pole—are of the flat blade type. Rated 10 amperes, 250 volts; 15 amperes, 125 volts.**

General Purpose ***Series*** **Available with cast metal housings in many types for circuit breaking and disconnect service. 30 amperes, 125 volts DC, 250 volt AC—1, 2, 3, 4, 5 and 6 pole. 60 amperes, 250 and 600 volts—3, 4 and 5 pole. 100 ampere, 250 and 600 volts—2, 3 and 4 pole. Also many special types, fusible and fuseless, for varied applications.**

*TRADEMARK REG. U. S. PAT. OFF.

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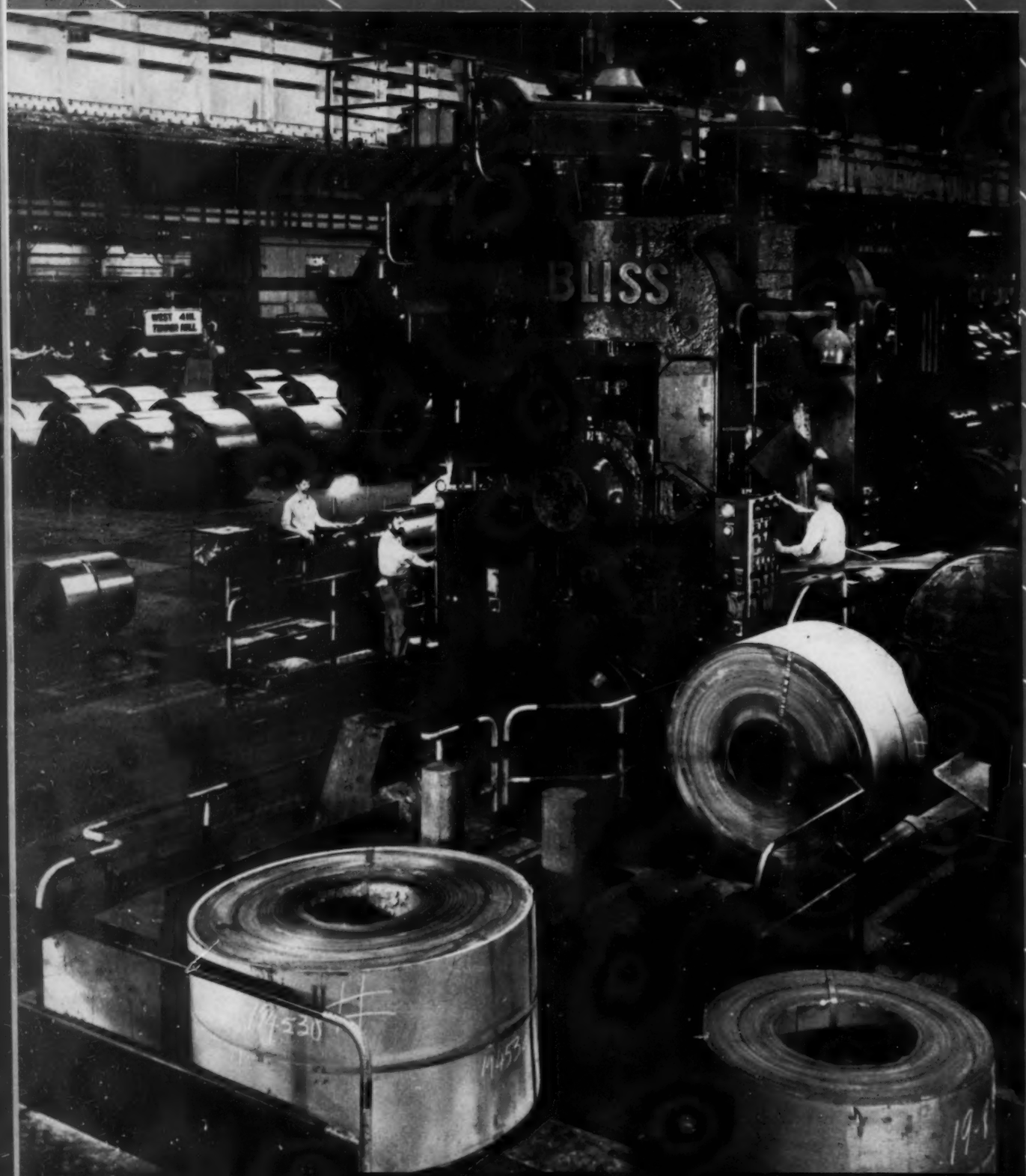
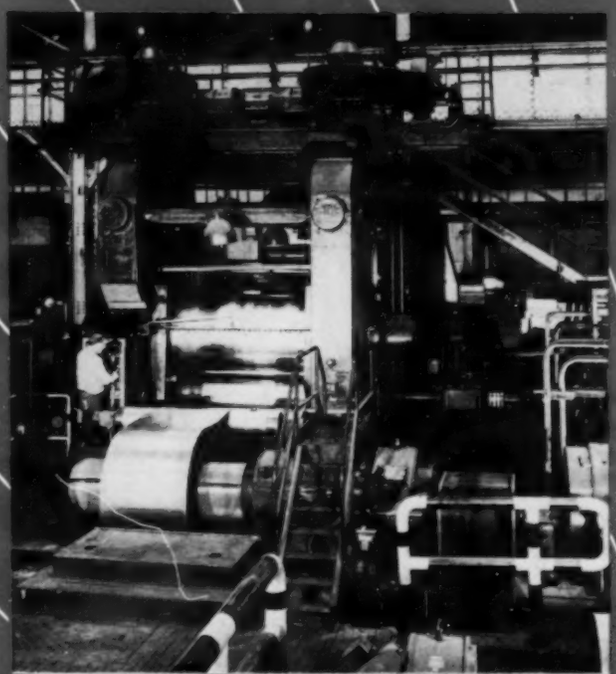
Revitalized Bliss Four-High Mill



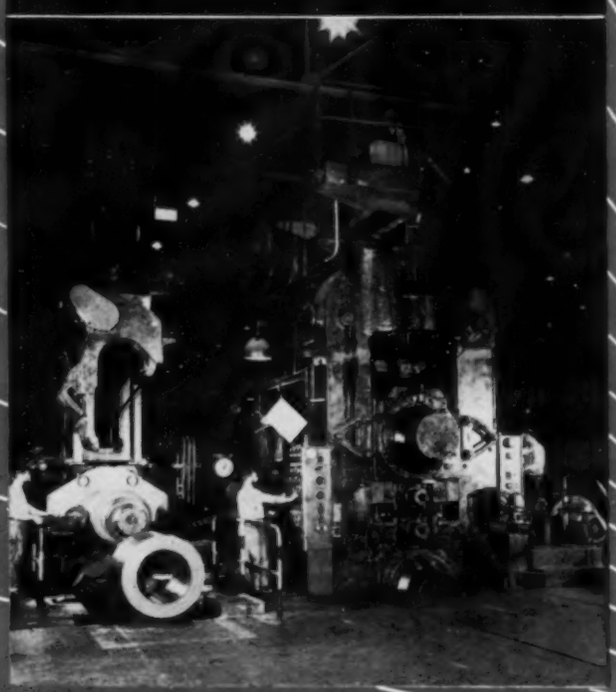
Entry conveyor, special up-ender, and pay-off reel-loading device feed coils rapidly into 84" four high temper mill.

Delivers 74,000-lb. Coils at 2000 fpm



Massive reel to pay off 74,000 lb. coils is shown on entry side of the mill.

Operator actuates controls to accelerate mill from threading speed to 2000 fpm in eight seconds.



Increased Horsepower and Improved Coil-handling Equipment Raises Production Standards at Gary Sheet and Tin Mill

Yesterday's equipment, even when well designed, is incapable of keeping pace with current production requirements. Recognizing this, engineers at U. S. Steel Company's Gary Sheet and Tin Mill, asked Bliss to recommend equipment and methods to utilize full production capacity of one of their four-high temper mills. Here's how Bliss engineers transformed a 20-year-old mill into a high-speed, modern installation:

- Bliss designed auxiliary reels to handle coils of unprecedented weight—74,000 lbs. in 74″ widths.
- Bliss re-powered the mill to deliver at 2000 fpm, and permit faster acceleration/deceleration. This faster pickup —permitting acceleration from threading speed to 2000 fpm in eight seconds—is a significant production step-up.

Engineering new and added life into old equipment is practical and effective. Bliss can point to many successful achievements of this type in steel, brass and aluminum mills. So whether you want to revitalize the old or create the new, it will pay you to consult Bliss. Start now by writing for your copy of our 52-page brochure. It shows how Bliss designed many outstanding installations.

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ROLLING MILL DIVISION: SALEM, OHIO
E. W. Bliss (England) Ltd., Derby, England
E. W. Bliss Company (Paris), St. Ouen sur Seine, France

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Write on company letterhead for Bliss' 52-page Rolling Mill Brochure.

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for Presses, ROLLING MILLS and Special Machinery... ***It's Bliss***

How to make MORE steel with LESS FUEL

IT'S been proved many times that the Morgan-Isley equipped regenerative furnace will outperform the conventional natural draft furnace in many ways. The Morgan-Isley produces more because it speeds up the furnace. The Morgan-Isley reduces fuel consumption because it provides a constant, measured flow of high temperature combustion air.

The Morgan-Isley System has decreased fuel consumption more than 15% and increased production more than 12% as compared to ordinary natural draft furnaces in the same shop.

Let's get together and talk Morgan-Isley in relation to your problem.

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Regenerative Furnace Control

MORGAN CONSTRUCTION COMPANY WORCESTER, MASS.

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ARE YOUR BEST POWER BUY— AT ANY PRICE

They ASSURE high maneuverability of trucks . . . rapid, accurate handling of material . . . PROVIDE uniform rate of material handling with no unscheduled down time . . . SHOW lowest costs of operation, maintenance, repair, depreciation, inherently safe. Call in an Exide Representative, and let him prove these facts.

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Exide Batteries of Canada, Limited, Toronto
"Exide-Ironclad" *Reg. Trade-mark U.S. Pat. Off.*

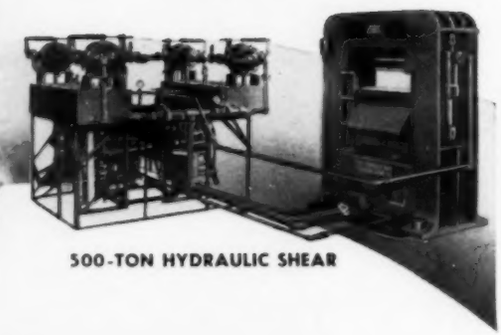
STEEL MILL EQUIPMENT

Precision built

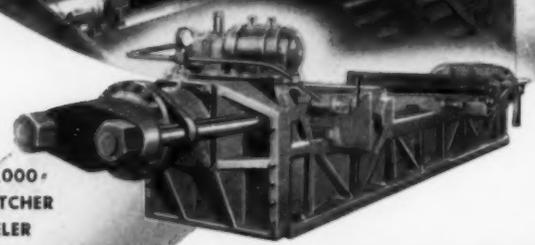
BY

F & Y m

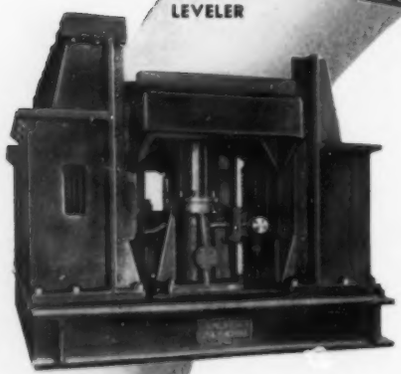
100" SCRUBBER LINE



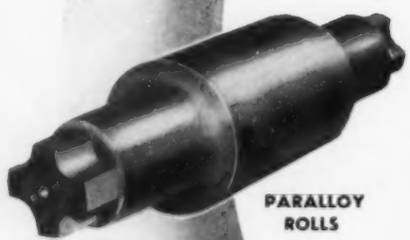
500-TON HYDRAULIC SHEAR



800,000# STRETCHER LEVELER



SLAB PILER



PARALLOY ROLLS

Check this List for the Products You Need

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- STRIP AND SHEET OILING EQUIPMENT
- SHEET SCRUBBER AND CLEANING LINES
- HOT SAWS—ROCKING AND SLIDE TYPES
- HOT BEDS—COOLING BEDS—TRANSFERS
- BILLET EJECTORS—PINCH ROLL STANDS
- SLITTERS—SPECIAL SHEARS AND GAUGES
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- Continuous PICKLING Lines—ROLLER LEVELERS
- FURNACE Charging Equipment—Furnace Pushers
- Strip Steel COILERS and REELS—SCRAP BALLERS
- RAILROAD Spike Forming Machines—ROLL LATHES
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The Youngstown Foundry & Machine Co.

OVER SIXTY YEARS OF SERVICE TO THE STEEL INDUSTRY

Youngstown, Ohio

Publication Service...

DECEMBER, 1951

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... any of the bulletins reviewed in the Publication Service of the IRON AND STEEL ENGINEER without obligation or cost. Simply circle the desired item numbers on one of the prepaid postal cards and mail. The requests will be forwarded to the manufacturers involved who will send the bulletins to you.

(1) Continuous Grinding

"Continuous Grinding," a new 28-page catalog in which ball, tube and rod mills are detailed, has just been published. Available with a variety of grinding media, these mills operate on the continuous principle, in which the material to be ground is fed continuously through a hollow trunnion at the feed end and discharged continuously at the discharge end. They are adaptable to wet or dry grinding, open or closed circuit grinding, and grinding as fine as 10 microns or as coarse as 4 mesh. Included in the catalog are over 50 illustrations; technical descriptions; and charts which show size, weight, linings, ball charge, speed, power requirements and motor sizes for the various Patterson mills. Also, special consideration is given to accessory equipment such as feeders and mill drives. In addition to descriptions of the mills themselves, complete continuous grinding systems are discussed. (514). Patterson Foundry & Machine Co.

(2) Electric Trucks

A new 12-page brochure describing their complete line of electric trucks in capacities from 1000 to 100,000 lb has been prepared. The booklet describes generally, the types of Yale electric trucks available, their features, a table to aid in selection, and application data. (P5151). Philadelphia division, Yale and Towne Mfg. Co.

(3) Measuring Equipment

A new 80-page catalog summarizing for the first time under one cover all of General Electric Co.'s testing and measuring equipment for laboratory and production line use, has been announced as available. To be used primarily as a reference to the apparatus available for the complex measurements to be made in industry, the new catalog contains more than 150 photographs and diagrams and describes the uses, features, specifications and prices of more than 130 G-E testing and measuring equipments. The new catalog also contains publication references to G-E bulletins that describe each device in more detail. (GEC-1016). General Electric Co.

(4) Belt Conveyors

Belt conveyors are really capable of transporting tonnages far in excess of any currently practical requirement, according to a technical article by L. O. Millard, assistant general sales manager of Link-Belt Co. Heightened efficiency and broadened versatility of the belt conveyor have been achieved through application of advanced engineering and materials like the new textile and steel reinforced belts, which he said are four to ten times stronger than their predecessors. New solutions to the problems of drive motors and power application and more careful consideration of friction factors, slippage and slack are other contributions of mechanical engineers to high performance, Millard added. A copy of this article is available to you. (2398). Link-Belt Co.

(5) Carbon Mold Plugs

A revised catalog section covering "National" carbon mold plugs is announced. These carbon mold plugs help to improve the quality of the cast ingot, prolong life of equipment, improve operating practice and are economical to use. They have been accepted by a steadily increasing number of companies. The catalog lists the advantages of carbon mold plugs as: elimination of inclusions in the ingot from the mold plug; little or no carbon pickup; plugs will not stick to the ingot and may be used more than once; they are light in weight yet mechanically strong; they can be handled without damage and may be securely placed in the mold opening without crushing, cracking or chipping of corners; they are consistently accurate in dimensions; leakers are reduced to a negligible percentage and steel loss and burning of mold buggies are reduced accordingly; and mold life is reported increased. Stock sizes available for immediate shipment and the standard sizes not carried in stock but supplied on order in quantities of 1000 or over are listed. Mold plugs are either packed in substantial corrugated cartons or palletized for shipment. (S-5600). National Carbon Co.

(6) Silicone Insulation

A booklet — "H, in a Class by Itself" — is available that is designed to point out some of the fundamentals of silicone insulation as applied to Class H transformers. It will acquaint you with some of the characteristics of Class H Insulation as compared with Class A and Class B insulating materials. (951). Pennsylvania Transformer Co.

(7) "Heat Processing . . .

. . . With The Most Advanced Techniques And Equipment," is the title of a new bulletin just issued. It approaches heat processing through five basic questions: what is to be heated, what sections are to be heated, why the material is to be heated, to what temperature or temperatures, and the heating time. The bulletin illustrates the application of high-production heating principles to solid and fluid products ranging in size from mill operations to delicate enameled pieces. (S-7.1). Selas Corp. of America.

(8) Carbon and Graphite

A brand new 20-page catalog section describing and illustrating "National" carbon and graphite and "Karbate" impervious carbon and graphite products is now available. Products made of carbon and graphite in grades from porous to impervious for applications in the chemical and process, metallurgical, mechanical and electrical

fields are fully described. Information is given on sizes and physical characteristics of each product, in addition to many useful tables such as, typical physical properties of carbon and graphite products, corrosion resistance of "Karbate" products, heat conductivity of various materials, performance curves of "Karbate" pumps, permeability of porous carbon and graphite, etc. Various types of impervious graphite heat exchangers, pipe, fittings and valves, centrifugal pumps, towers and accessories; carbon or graphite structural shapes, brick and cement, blast furnace linings, mill and foundry products, electric furnace electrodes, motor and generator brushes, mechanical applications and ground anodes for cathodic protection, are but some of the many illustrated products. The principal features of carbon and graphite, whether porous, regular or impervious, are: resistance to practically all corrosive chemicals, high heat transfer of graphite products and low heat transfer of carbon products, ease of machining and fabrication, resistance to severe thermal shock, low thermal expansion, strength maintained with no deformation at high temperatures and good electrical conductivity. (S-5005). National Carbon Co.

(9) Metal Cutting

"Getting Down to Cases on Metal Cutting" is the title of an interesting 32-page book recently compiled. Containing actual performance records with accurate facts and figures, this well illustrated book shows the advances made possible with modern cutting fluids. Examples of greater production, sizable savings in time and costs, plus finer finish and longer tool life, are well presented in this collection of authoritative case histories. Such details as actual machine feeds and speeds, types of machines, grades of steel, and dilutions of the cutting fluid are included. E. F. Houghton & Co.

(10) Power Plant Coal Handling

A new 44-page book on coal and ash handling equipment for power plants, has just been published. The book contains helpful layout drawings and interesting photographs of actual installations. It is truly a book of ideas and suggestions for solving the coal and ash handling problems of today's power plants. The pictures include installations at both large and small public utility, industrial and public building power plants. And they show installations at new power plants as well as boiler houses that were modernized, enlarged or improved after the original installation. There are sections in the book on unloading coal, auxiliary unloading, coal storage and reclaiming, crushers, transporting and distributing equipment, ash handling, and water intake screens. (2410). Link-Belt Co.

(11) Refractory Coating

"Cera-Kote," a super refractory coating made from a combination of ceramic and metallic materials and said to" . . . make good refractories last longer — serve better" is described in a bulletin just released. The bulletin cites many product tests in its application to refractories such as those used in industrial heat treating furnaces, kilns, ovens, boilers, etc., where the super refractory coating has increased refractory life by as much as 30 per cent. A partial check list of users and uses of this refractory coating are included, noting application to both brick and plastic refractories. The coating serves as a preventative against slag penetration, abrasive wear, flame erosion, corrosive gases, molten metal, and thermal shock. Williston & Co.

(12) Welding Equipment

A new catalog on "Aircomatic" equipment and wires has been announced. This catalog describes the "Aircomatic" gun for manual operation, the "Aircomatic" head for automatic operation and the "Aircomatic" wires for use with either manual or automatic equipment. Photographs and sketches of the equipment are supplemented by on-the-job illustrations of a few of the many applications. (ADC 717). Air Reduction.

(13) Stud Welding

"How to Design for Nelwelding," a concise 8-page manual prepared to aid designers and production engineers in the fast, economical solution of fastening problems, has been issued. In addition to listing stud specifications and recommended stud selection guides, the manual presents detailed suggestions concerning template design, provisions for accommodating fillet and a table on minimum stud clearances applicable to the portable Nelson stud welding gun. (D-1). Nelson Stud Welding Division, Gregory Industries, Inc.

(14) Induction Heating

A new 12-page bulletin on equipment for induction heating has been announced as available. The illustrated booklet describes forging, hardening, brazing, and annealing applications at 1000, 3000, and 10,000 cycles. It explains the components and requirements of induction heating with motor-generator type equipment and also covers such applications as forge welding, heating drill bits, continuous heating of moving strip, and surface hardening. (GEA 5679). General Electric Co.

(15) Prepared Gas Atmospheres

A new illustrated bulletin on industrial applications of gas chemistry for heat treating has just been released. Exothermic and endothermic type atmosphere generators are described and the gas generation processes schematically diagrammed. Compositions of each gas atmosphere and the respective heat treat process applications are described. In addition, notable examples of furnace design applications for continuous or batch production controlled atmosphere heat treating are presented. The gas constituents, generator capacities, application data and operating costs for all of the prepared gas atmospheres are tabulated for handy reference in selecting atmospheres. (SC-155). Surface Combustion Corp.

(16) Water Hammer Study

The cause, effect and control of water hammer in piping systems are considered in a new bulletin just published. After describing water hammer in non-technical terms, the brochure indicates its potential damage to piping, instruments and other parts of water systems, and then considers methods of controlling it. A phase of hydraulics about which little is known, water hammer was studied in detail in several hundred tests. Among other things, the intensity, the action of the pressure wave and the origin of water hammer were studied. Shown in this new brochure are a number of curves representative of some of these tests. The curves indicate pressures

up to 304 lb developed in 1/10 of a second, and illustrate the bellows-like expansion and contraction of a pipe subjected to water hammer. Also included in the booklet are the results of further tests made to determine what effects check valves have in overcoming water hammer. Both tests on conventional swing check valves and the newer type silent check valve are reported. (WH-851). Williams Gage Co.

(17) Speed Reducers

A pocket-size catalog of speed reducers and right angle gear motors is announced for distribution. The 96-page book gives complete engineering data on how to select the proper speed reducer to fit requirements, including horsepower ratings, ratios and installation graphs. (51). Abart Gear & Machine Co.

(18) Pressure Switches

A 32-page manual on pressure switches has just been published to promote a better understanding of the complex problems involved in the proper application of this vital electric-hydraulic link. The book includes a glossary of terms, a tabulation of available units based on function and pressure or vacuum range, diagrams for circuit detailing, an electrical rating table and other important application data. It presents a comprehensive coverage of operating characteristics for diaphragm, bourdon tube, and piston type pressure actuated switches, from extreme vacuum to extreme pressure. (1BM-1). Barksdale Valves.

(19) Pre-Lubricated Bearing Design

Reliance pre-lubricated bearing design, which provides more hours of motor operating life without relubrication than any other pre-lubricated bearing, is the subject of a bulletin recently published. The illustrated folder contains descriptive sketches, cutaway drawings of the improved double shielded bearings and their bracket mounting, and a check list which compares other bearing arrangements with the Reliance design. (B-2201). Reliance Electric and Engineering Co.

(20) Liquid Level Controls

A catalog is available describing "Magnetrol" liquid level control for practically any liquid at any pressure or at any temperature. This catalog discusses the switching principle used in "Magnetrol" controls, the advantages of this control, and how it works. It also describes the various types of level controls available as well as giving standard and special applications. Magnetrol, Inc.

(21) Thermocouple Accessories

Just published is a new edition of a thermocouple and pyrometer accessories bulletin, listing many new items and containing new data on the proper application and use of thermocouples. The 56-page bulletin contains a well illustrated catalog of hundreds of pyrometer supply items, including assembled thermocouples, thermocouple wires, extension wires, protection tubes, insulators, and accessories for the full range of industrial pyrometer applications. Technical information and installation sketches have been added to the "Users' Manual" section, which contains engineering data on modern practices in pyrometry. Also included are tables of calibration data for the commonly-used base metal and rare metal thermocouples. (P1238) Bristol Co.

(22) Lifting Magnet Aid

Just printed for lifting magnet users is a card for hanging in crane cabs. Magnet crane operators are prone to switch a magnet to the "lift" position, feeling that time is saved by this shortcut method of operation. They overlook the loss of efficiency and waste of power when operating a magnet on a nearly continuous duty cycle. (13-905) Electric Controller and Mfg. Co.

(23) Protective Lighting

Complete plans for outdoor industrial lighting are provided in a new 24-page booklet, "Light for Plant Safety and Security," available to you. Stressing that protective lighting is good productive lighting, the booklet sets forth four principles: (1) discourage attempts at entry; (2) make detection certain if entry is attempted; (3) aid the guard and hinder the intruder; (4) provide complete reliability. Application suggestions and techniques are given, such as the lighting of isolated fence boundaries, building-face boundaries, water front boundaries, and industrial thoroughfares. Various power distribution and control systems and mounting methods are provided. (B-4791) Westinghouse Electric Corp.

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PUBLICATIONS CURRENTLY OFFERED by Iron and Steel Engineer Advertisers

ITEM	COMPANY	BULLETIN	DESCRIPTION
50	AMERICAN AIR FILTER CO., INC.	BULLETIN 250F	Gives the full story on super-clean air protection for mill motors.
51	AMERICAN CHEMICAL PAINT CO.		Descriptive folder available on Rodine pickling acid inhibitors.
52	AMERICAN FLEXIBLE COUPLING CO.		Folder available on Amerigear fully crowned tooth.
53	BAILEY METER CO.	BULLETIN 230-C	Gives details on Bailey Pyrotron resistance thermometers.
54	BLISS CO., E. W.		52-page brochure available on rolling mills and accessories.
55	BRISTOL CO.	BULLETIN E1111	Contains latest data on recording instruments.
56	BROWNING AND CO., INC., VICTOR R.	BULLETIN "E"	Describes Browning mill type cranes.
57	CITIES SERVICE OIL CO.		Information available on combustion control for industry.
58	CLEVELAND WORM AND GEAR CO.		Catalog contains specifications and other details of the complete Cleveland line.
59	COLUMBIA ELECTRIC MANUFACTURING CO.		Descriptive bulletins available on Columbia motor generators.
60	CUNNINGHAM CO., M. E.	BULLETIN J-547	Tells about nailing identification tags to steel.
61	CUTLER-HAMMER, INC.	PUBLICATION BR-2	Gives information on the Type M mill brake.
62	DE LAVAL STEAM TURBINE CO.	MANUAL GWB-V	Gives complete details on the De Laval speed reducer.
63	DIAMOND POWER SPECIALTY CORP.	BULLETIN 1025	Tells about the Diamond "Utiliscope."
64	DURABLA MANUFACTURING CO.	BULLETIN S12	Contains facts on Durabla pump valve units.
65	ELECTRIC CONTROLLER AND MFG. CO.	BULLETINS 1075, 1076, 1077 AND 1078	Describe EC&M synchronous starters.
66	ELECTRIC SERVICE MANUFACTURING CO.	BULLETIN 681B	Gives complete information on the Keystone LMI pony size collectors.
67	ELLIOTT CO., CROCKER-WHEELER DIVISION		Mill motor and sealed power motor bulletins available.
68	FARREL-BIRMINGHAM CO., INC.		Bulletins available on HD and TT type roll grinders.
69	FOOTE BROS. GEAR AND MACHINE CORP.	BULLETIN LPB	Describes Foote Bros. Line-O-Power drives.
70	GENERAL ELECTRIC CO.	BULLETIN GEA-5408	Describes G-E d-c crane drives.
71	HARNISCHFEGER CORP.	BULLETIN C-42	Tells about P&H mill type cranes.
72	INDUSTRIAL GEAR MANUFACTURING CO.	BULLETIN 149	A trip through "Industrial Gear" is graphically illustrated.
73	JONES FOUNDRY AND MACHINE CO., W. A.	BULLETIN 68	Covers selection tables and dimensions.
74	KOPPERS CO., INC., FAST'S COUPLING DEPT.		Detailed descriptions available in Fast's catalog.
75	MARVEL ENGINEERING CO.	FOLDER 105	Gives the facts on Marvel synclinal filters.
76	MEDART CO.		Illustrated brochure available on Medart centerless turner.
77	NORTHERN ENGINEERING WORKS	CATALOG 156-C	Gives the facts on Northern cranes.
78	PITTSBURGH LECTROMELT FURNACE CORP.	BULLETIN 7	Describes in detail Lectromelt furnaces.
79	POOLE FOUNDRY AND MACHINE CO.		Catalog obtainable on flexible couplings.
80	POST-GLOVER ELECTRIC CO.	BULLETIN 500	Gives detailed information on P-G steel grid resistors.
81	RELIANCE ELECTRIC AND ENGINEERING CO.	BULLETIN D-2311	Tells about V*S drives.
82	STANDARD CARBON CO.		Catalog available on Standard Carbon products.
83	TAYLOR SONS CO., CHAS.	BULLETIN 507	Describes Tayco-40 silica cement.
84	TRUFLO FAN CO.		Illustrated literature available on Truflo fans.
85	WESTINGHOUSE ELECTRIC CORP.	BULLETIN B-4730	Gives the facts on Westinghouse Series 600 mill motor.
86	YALE AND TOWNE MANUFACTURING CO.		Detailed literature available on Yale electric trucks.
87	YORK ENGINEERING AND CONSTRUCTION CO.		Circular available on greater efficiency in plant construction and engineering.
88	YOUNGSTOWN WELDING AND ENGINEERING CO.		Descriptive literature available on Weldco crates.

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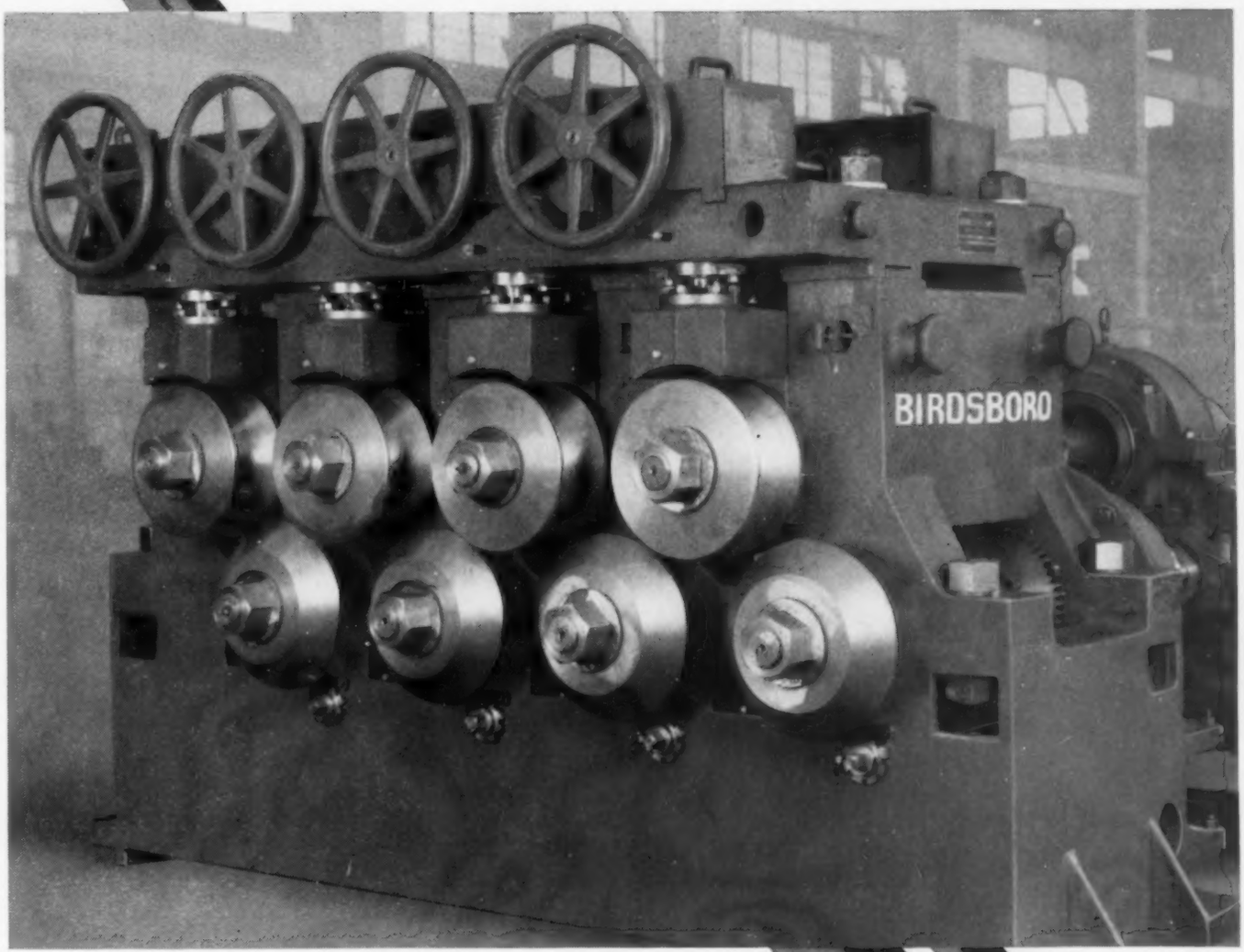
Means Faster Straightening



You can eliminate downtime for roll settings because *all adjustments can be made while this angle straightening machine is in operation.* All top rolls are axially and vertically adjustable with one being driven through a slip clutch and universal spindle. All bottom rolls are axially adjustable—and all are driven.

If you are producing angles up to 3″ x 3″ x ½″, this BIRDSBORO straightener of the overhung type is your answer to today's demand for increased output. Here is one more typical example of BIRDSBORO's advanced engineering which you are invited to call on at any time to help solve your rolling mill problems.

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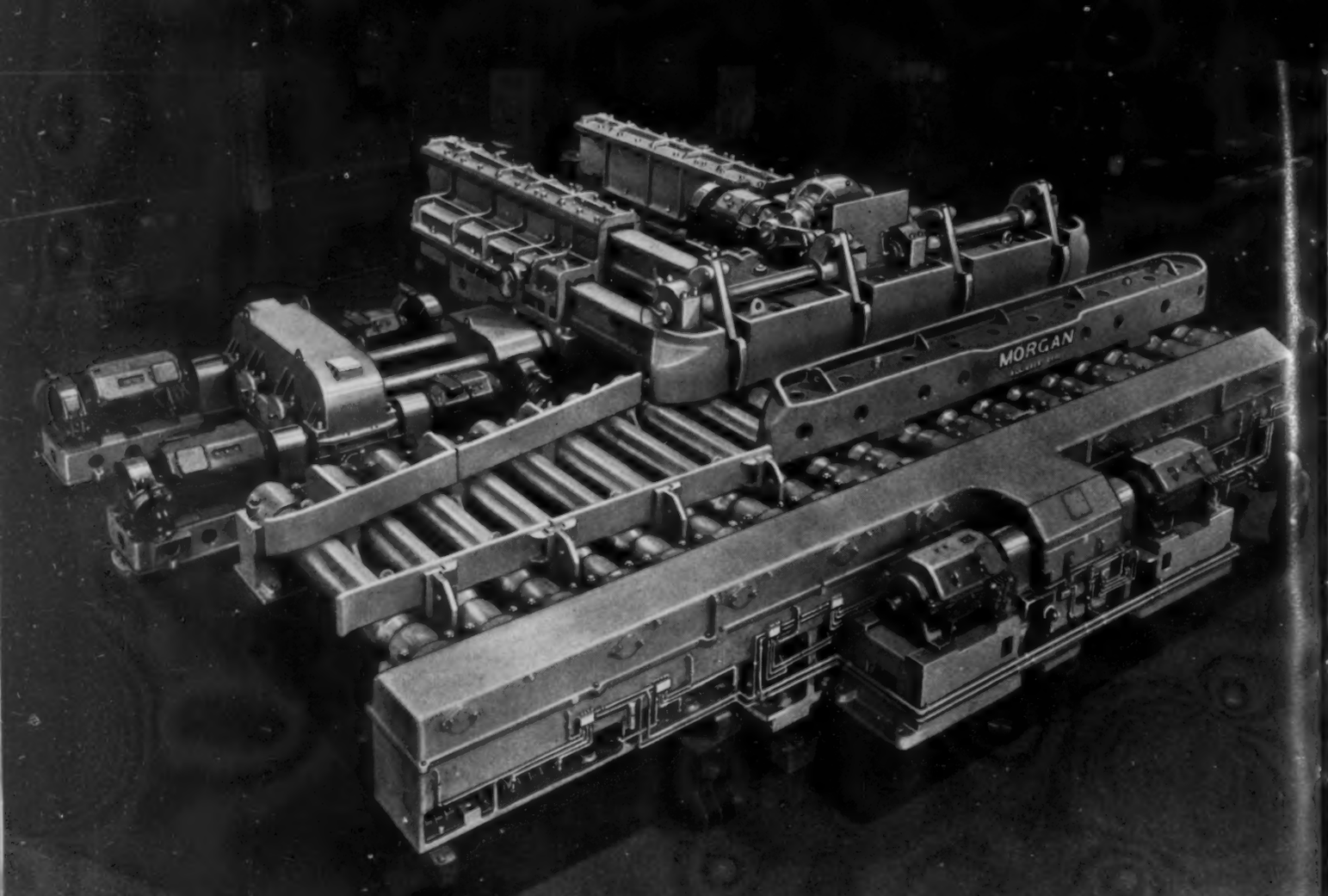

45″ BLOOMING MILL TABLE AND MANIPULATOR

Morgan 45″ Blooming Mill Manipulator with Front Mill Table. Manipulator is of the overhead type, electrically driven, with retractable heads so the table rollers can be removed without dismantling the manipulator heads. Table girders are of cast steel box section type with integral oil trough on drive side. All gears are totally enclosed, operating in oil, and have hardened teeth. All bearings are of the anti-friction type lubricated through a centralized motor operated system.

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Equipment News...

INDUCTION-WELD PIPE

▲ Yoder Co. has developed equipment for induction welding of pipe and tubing. This new process offers advantages for certain applications, notably the production of standard weight pipe in conventional butt-weld sizes.

The complete induction-weld mill consists of substantially the same units as a Yoder resistance-weld mill for cold-roll-forming of coiled strip or skelp into tubular shape, sizing, straightening and automatic cut-off, entirely eliminating the use of furnaces.

The welder, therefore, is the principal unit in the new process which is basically new and different from that of a resistance-weld mill, it being the first adaptation of induction heating principles to the welding of tubular products on a commercial scale.

Yoder management some four years ago decided to explore the possibilities of induction heating for any pipe or tube application in which it might demonstrate advantages over existing processes, including the cold-forming as well as the furnace type. Preliminary research and experiments carried out during the first year showed sufficient promise to encourage further development work, which was then undertaken in cooperation with the Tocco Division of the Ohio Crankshaft Co.

This company for years has been identified with the manufacture of induction heating equipment for hardening, heat treating and other industrial applications.

Toward the end of the second year, the development work had progressed far enough to establish practical certainty as to the speed, quality and economy of welding light gages (0.010 to 0.065 in.) at a high rate of speed, and of a quality especially suitable for EMT conduit, because of the absence of objectionable internal welding bead or flash.

The first mill was designed and built for this purpose and has by this time been in commercial operation for over a year. It is successfully producing EMT conduit at the rate of 75,000 to 80,000 ft per 8-hr shift. A production on this big scale answers the needs of the very largest producers and distributors in this country.

An application of much broader commercial possibilities is the making of pipe from ½-in. up to and including 2 in. nominal diameter. This range comprises the sizes of black and galvanized standard merchant pipe in the greatest demand for plumbing, heating, gas and other domestic and industrial uses. In the American market the demand for these sizes is so big in terms of footage that it can be most profitably met by mills of higher operating speeds than those which have heretofore been practical with cold-roll-forming mills incorporating alternating current resistance welding.

The latter type of mill, while extensively used for making both large and small pipe in many foreign countries, this country has heretofore proved most advantageous for making pipe and oil country tubular goods in larger sizes, involving bigger tonnages but smaller footage.

For these reasons, the Yoder-Tocco efforts during the past several years have been directed toward perfecting a mill for producing anywhere from 10,000 to 50,000 tons of mixed sizes, in the range indicated, without sacrifice of the inherent advantages of low initial investment, as well as low operating and maintenance cost which distinguish the cold-forming, resistance-weld process.

Top production of 50,000 tons would involve fairly continuous operation in 3 shifts per day, while the figure of 10,000 tons is estimated on the basis of single-shift operation and occasional shut-downs for longer periods. The low first cost and maintenance, due largely to freedom from furnaces, fuel and maintenance cost during idle periods, give the cold process an exceptionally low break-even point, and make possible profitable operation over the widest range of tonnage requirements.

The speed of the new mill ranges from about 165 fpm for 2-in. up to about 240 fpm for the ½-in. pipe.

The same mill will also make EMT conduit up to 4 in. diameter and British Standard (Class B) pipe up to 3½ in. diameter, inclusive. The mill will be equipped with a 750-kw, 10,000-cycle welder. After extensive experiments, this frequency was found most satisfactory for this application.

In respect to materials suitable for induction welding, not only can hot rolled stock be successfully used without first being cleaned, pickled or oiled, but open hearth as well as bessemer steel can be used with equal success. As with resistance welding, permissible carbon contents is from 0.10 per cent up to 0.50 per cent, or even higher. Multiple slit stock may be welded as readily as skelp. No process heretofore employed offers so wide a latitude and so many economies in the choice of materials for making welded pipe.

ROLL TYPE BEARINGS

▲ Tyson Bearing Corp. has announced the addition of a new size range in their standard line of full

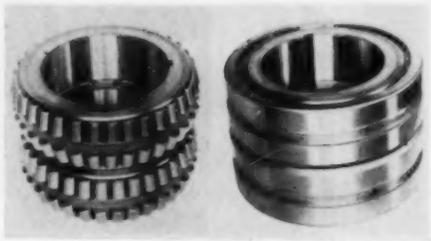
D-C GENERATORS

Prior to their shipment for installation in the new Kaiser Aluminum and Chemical Corp. plant being built at Chalmette, La., these d-c generators undergo final inspection at General Electric's Schenectady, N. Y., works. Part of a group of eighty such machines that will be supplied the giant $145,000,000 plant, each will generate 1290 kilowatts of power for the electrolytic reduction of alumina into aluminum. They will be driven by Nordberg gas-fuel radial engines of the two-cycle type. Initial shipment was made in May. The new reduction plant has scheduled production of 200,000 tons of aluminum in 1952.

roll type tapered antifriction one, two and four-row bearings. Single row bearings are available in sizes from 2 to 20 in. outside diameter; two-row bearings from 4 to 20 in. outside diameter; and four-row bearings from 6 to 20 in. outside diameter. These new full-roll units have been engineered for use in rod, bar and strip mills, pinion stands, gear drives, piercing mills, table rolls, reels, straighteners, cranes and other heavy metal-working machinery. By speeding roll changes, decreasing power consumption, reducing lubrication and maintenance costs and increasing general overall efficiency, they prove their superiority for heavy duty service.

The four-roll bearing shown measures 10¼ in. inside diameter, 15¾ in. outside diameter and 10 in. wide. This bearing is manufactured to AFBMA standards, with the bore held to 0.001-in. and the outside diameter to 0.002-in. tolerance, and is made entirely of high quality Krupp chrome-nickel steel. At 500 rpm, it has a 126,000-lb radial capacity and 24,250-lb thrust.

Tyson full-roll tapered roller bearings provide the maximum number of rolls of greatest capacity, rigidity and service life. The distribution of the load over a full complement of tapered rolls assures smooth operation at full radial and thrust capacities. Because of the close spacing of the rolls, possible deflection in cone and cup members is reduced to a minimum. Positive alignment is achieved by contact of the tapered rolls with the high back rib which is an integral part of the cone.



GEAR-TYPE COUPLINGS

▲ A new gear tooth design for gear-type couplings used in the transmission of power, has solved a wide variety of gearing problems for this type of connecting equipment, according to the manufacturers, American Flexible Coupling Co. The new design was developed from an engineering discovery made by the company which revealed a way to distribute the power load of connected equipment over a greater surface of each gear tooth. This fundamental improvement on an accepted design permits all the load to be carried on the strong flanks of the tooth rather than on the tooth edges as is common in conventional gear-type couplings, reduces backlash to a minimum, and provides greater flexibility.

The principle of the new tooth design is centered around the "fully crowned" shaping of the hub teeth of the coupling. They are so contoured on all contacting surfaces of the crown and flank that they present a tighter fit of exceptionally close tolerance with the internal spline teeth of the floating sleeves. This close, tight fit is said to have solved the long standing gearing problem of "end tooth and tip contact," and provides for greater freedom of axial movement. To compensate for misalignment between connected shafts within the gearing, the length of the hub teeth was increased by an amount equal to the

Cobbles don't destroy this

X-RAY THICKNESS GAGE

AT WEIRTON STEEL . . .

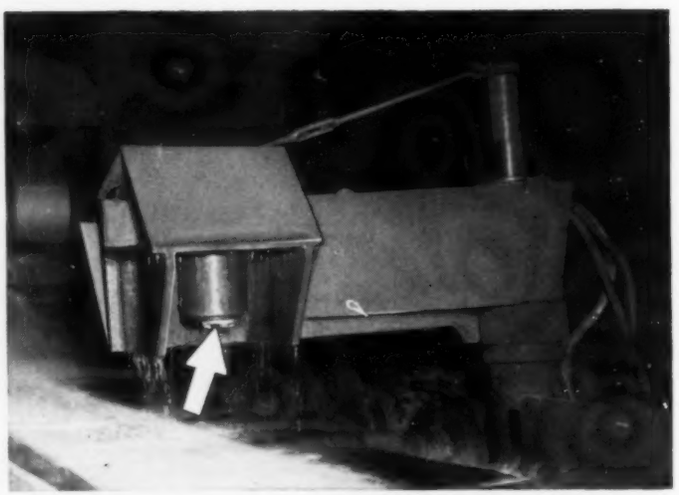
. . . hot strip races beneath the top detector of a G-E X-Ray Thickness Gage at speeds exceeding 1700 fpm. Mill operators claim it has enabled them to reach gage on the first slab, where formerly four slabs would go through the mill before a report could be obtained.

This unit has given excellent service since its installation in March 1949.

Now mill operators can:

- Reach gage on the first slab
- Cut down on re-rolls
- Boost on-gage tonnage

Ask your G-E representative for more information about the X-Ray Thickness Gage, or write Sect. 687-80, General Electric Company, Schenectady, N. Y.



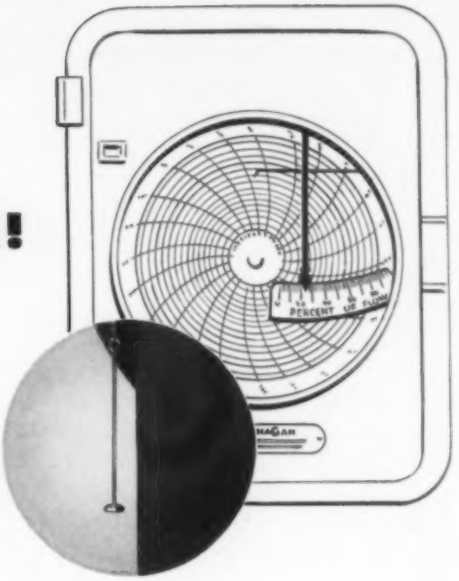
Top detector of G-E 100-kv X-Ray Thickness Gage (arrow), shown mounted on 66" hot-strip mill at Weirton, W. Va.

GENERAL ELECTRIC

687-80

One man can check a

HAGAN RING BALANCE METER!



He needs only a handful of check weights!

The calibrated check weights supplied with each meter are stamped with the equivalent in inches of water differential. An easy calculation gives the relation between differential pressure and meter reading.

Here is all you do to check a Hagan Ring Balance Meter:

1. **Without closing the shutoff valves, simply equalize the lead lines**
2. **Check for zero**
3. **Put check weights on ring assembly**
4. **Read pointer or pen position.**

Checking the Hagan Meter minimizes meter outage time. Sounds easy? It's just as easy as it sounds.

HAGAN CORPORATION

RING BALANCE FLOW AND PRESSURE INSTRUMENTS
THRUSTORQ FORCE MEASURING DEVICES
BOILER COMBUSTION CONTROL SYSTEMS
METALLURGICAL FURNACE CONTROL SYSTEMS

HAGAN
HALL
BUROMIN
CALGON

The check weight system for checking HAGAN *Ring Balance Meters is:*

★ **ACCURATE**—check the Hagan Ring Balance Meter under full static pressure.

★ **CONVENIENT**—a handful of check weights does the trick—no cumbersome equipment.

★ **TIME—AND MONEY-SAVING**—only one man is needed, and he can check the Hagan Meter in a very few minutes.

For information about Hagan Ring Balance Meters and how they can work for you, write to Hagan Corporation, Hagan Building, Pittsburgh 30, Pa.

Hagan Corporation
Hagan Building
Pittsburgh 30, Pennsylvania

Please send me further information on Hagan Ring Balance Meters. I am particularly interested in.....

NAME.....

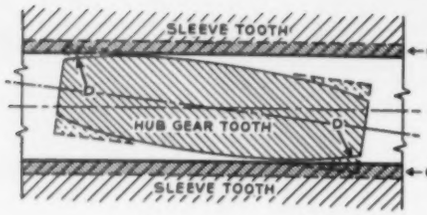
POSITION.....

COMPANY.....

STREET AND NUMBER.....

CITY..... ZONE..... STATE.....

IS-12



normal clearance for standard teeth, and the tips were crowned with a radius equal to the outside radius of the gear. The design allows the tip of each tooth to contact the root of the internal spline tooth in the sleeve of the coupling, piloting it with a ball and socket action. Chamfering the tooth edges avoids interference with the spline tooth fillet and transfers the contact to the broad flank of the gear tooth. Thus, the flank, or strongest surface of the tooth, carries all the load while providing for the correction of lateral and angular misalignments.

This "fully crowned" tooth design is incorporated in the company's "Amerigear" type couplings, and has been adapted to many different applications for power transmission. Typical installations include those which vary considerably from standard applications, and in which the unusual mechanical advantages of the new tooth design were utilized to solve complex and troublesome power transmission problems.

HOT BLOOM SHEAR

▲ An electrically operated hot bloom and slab shear designed by the Loewy Rolling Mill Division, Hydropress, Inc., has recently been placed in operation by the Alpine Montan Co. of Austria at their Donawitz plant. The shear operates in conjunction with a modern 44 in. blooming and slabbing mill and is capable of cutting hot blooms or slabs up to 16 in. by 16 in. or 40 in. by 6½ in. respectively, exerting a shearing force of 1150 tons.

Driven by two 300 hp electric motors this mechanically simple shear of the upcutting type operates from the standstill without flywheels or clutch. It is fully electrically controlled assuring high productivity and eliminating many common shearing troubles.

A variety of cutting speeds and an electrically adjustable knife opening combine to permit quick adaptation for the cutting of various sizes of material making the shear extremely versatile in operation.

The knives are fully supported along their entire length in a solidly constructed carrier eliminating any undue bending stresses caused by overhung loads as is the case in other similar shears. The lower knife carrier is activated by a system of levers which is arranged in a manner to absorb all working stresses and leave the shear frame proper completely free of any stresses during the cutting operation. Positive control of the bloom or slab is accomplished by means of a spring loaded hold-down which clamps the material tightly in place while cutting, and releases it as soon as the lower knife has descended sufficiently to let the material pass between the shear blades. With electrically operated push-off arms placed in front and back of the shear knives and allowing quick disposal of the crop ends, the shear is immediately ready for the next cut.

The shear frame is designed in a manner to allow free access to all parts for inspection and maintenance, and in particular the open shear throat can be easily reached by the operator.

These special features and many others incorporated by Loewy in the

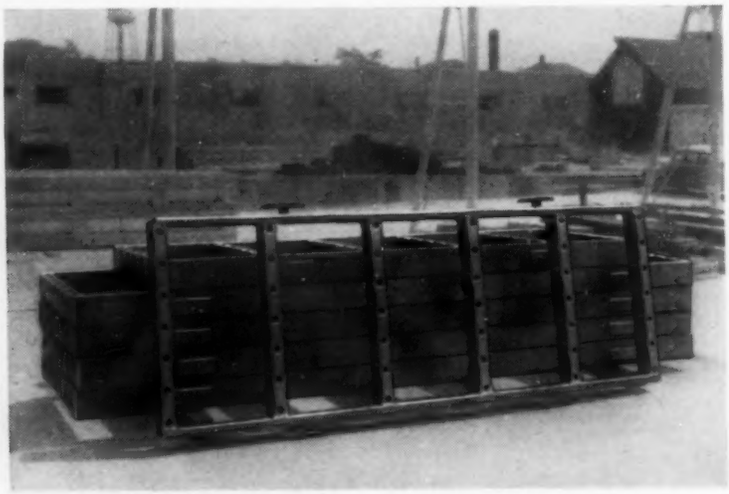
WELDCO Pickling Crates

With the New Pierced-

Type Cross Members

Offer Bigger Payloads—

Longer Service Life



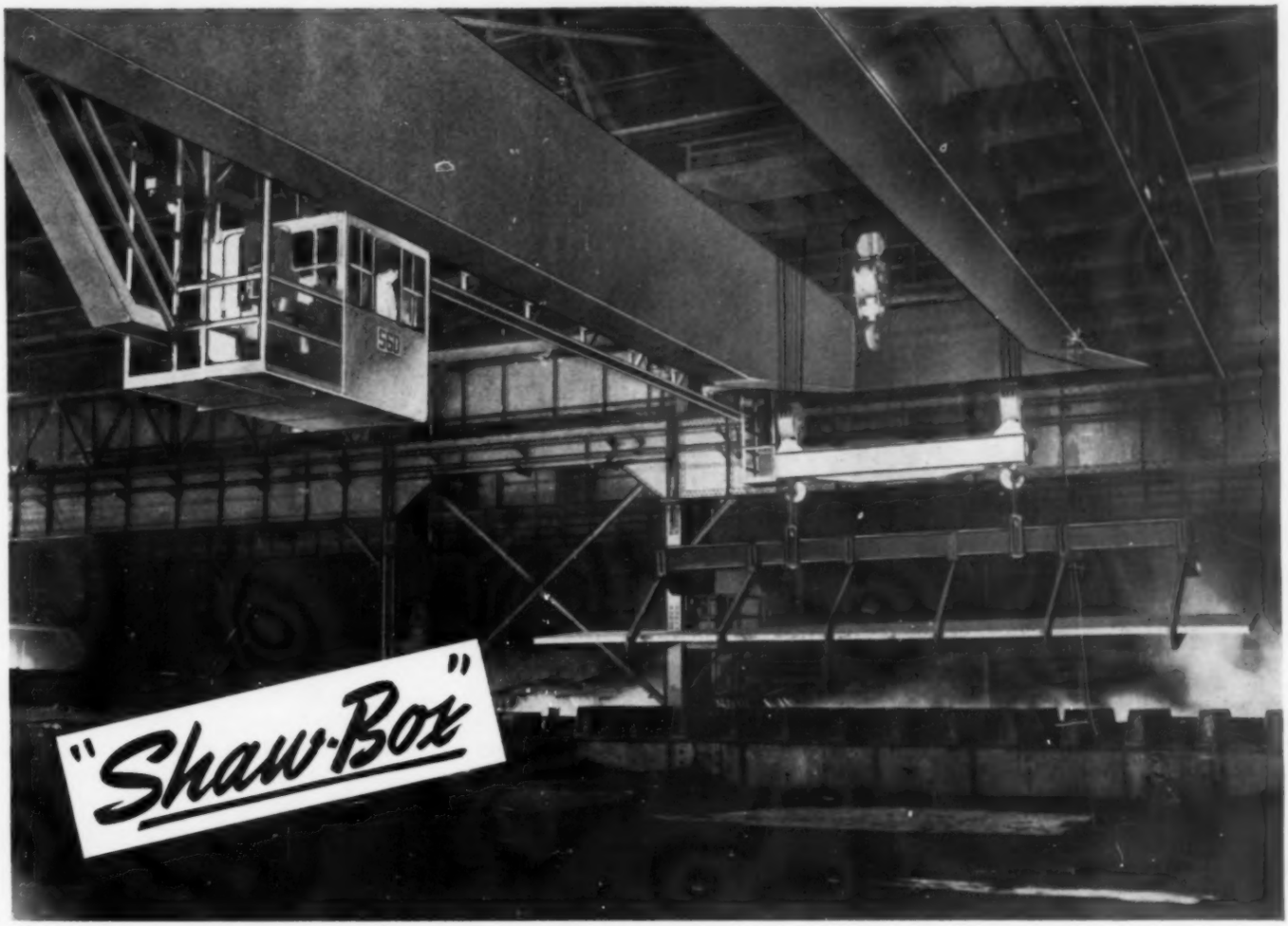
• These six Weldco pickling crates, made of Monel, are now in use in a Gary, Indiana, sheet mill. Sturdy and long-lasting, they're pickling sheet steel in a 5 to 10% sulphuric acid bath at 160° to 180° F. An **extra** feature of these Monel crates is the new, pierced-type cross member, with these cost-cutting advantages:

1. Greater strength--more tonnage per load.
2. Less hole distortion or enlargement. The taper pins remain tight—do not become loose or wobble.
3. Less time needed for loading, as less time required for placing pins, due to tapered hole.
4. Only a small surface is exposed to attack by acid. Cross member retains its strength longer, and there are fewer replacements.

Why not find out how these long-lasting Weldco crates can improve your pickling operations? Write or phone today for complete details and descriptive literature.

THE YOUNGSTOWN WELDING & ENGINEERING COMPANY

3720 OAKWOOD AVENUE . . . YOUNGSTOWN 9, OHIO



CRANES . . . FOR THE STEEL MILL

When your Steel Mill Cranes are "Shaw-Box," they are built with an intimate understanding of mill requirements, gained through years of working closely with the steel industry. Manufactured to exacting standards of fine engineering and precision workmanship, each one stands out as an example of the interpretation that can be made of individual mill or AISE specifications. Simple, rugged, and extremely accessible, they include the extra values of advanced design and construction excellence for which "Shaw-Box" Steel Mill Cranes are known and recognized throughout the industry. The plus advantages of "Shaw-Box" experience and precision manufacturing methods insure you trouble-free operation and dependability, with minimum maintenance costs, under the most severe operating conditions.

For the greatest value in dependably superior crane service you can buy, look to "Shaw-Box."

Be sure to send all your inquiries for Steel Mill Cranes and Soaking Pit Carriages to "Shaw-Box."

MANNING MAXWELL & MOORE INC. TRADE MARK

MANNING, MAXWELL & MOORE, INC.

SHAW-BOX CRANE & HOIST DIVISION

MUSKEGON, MICHIGAN

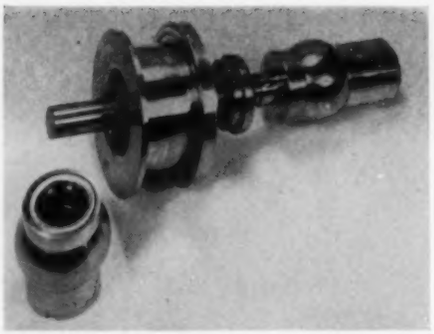
Builders of "Shaw-Box" Cranes, 'Budgit' and 'Lead-Lifter' Hoists and other lifting specialties. Makers of 'Ashcroft' Gauges, 'Hancock' Valves, 'Conselidated' Safety and Relief Valves, and 'American' Industrial Instruments.

design of their shear, as well as its mechanical simplicity guarantee a trouble-free and safe operation and a minimum of maintenance in spite of the extremely heavy service required of this type of machine.

CEMENTED CARBIDE

▲ Successful experimental use of cemented tungsten carbide bearings under high speed, high load, and temperature conditions where conventional bearings fail, was recently revealed by Carboloy department, General Electric Co.

Although not as yet developed to a commercial state, progress to date indicates a strong possibility that critical bearing problems may be solved in the near future by the use of carbide metals since industry may soon reach the point where loads, speeds and operating temperatures can no longer be handled successfully by conventional bearings and bearing materials. As yet, it cannot be said with certainty that carbides will provide the complete answer, but bearings made of tungsten carbide meet the operating requirements of high speed, high loads, and high temperatures, better than any other metal known today.



Bearings of Carboloy cemented carbide as used on a Brown and Sharp grinder spindle. Use of carbide permitted such small bearing clearances that parts ground on the machine could be held to 0.0001 in. and still leave sufficient lapping stock, thus reducing lapping time by 50 per cent. Both spindle and bearings are tungsten carbide.

Some rather remarkable results have already been obtained with experimental installations and in laboratory tests. Plain sleeve type bearings consisting of carbide running against carbide have been run successfully at speeds up to 30,000 rpm and at loads up to 2000 psi. In one typical series of tests of a ¾-in. diam ¾-in. long bearing, run at 10,000 rpm, the temperature rise when the load was increased from 100 to 1000 psi was only 5 degrees, indicating unusual efficiency—very low power loss.

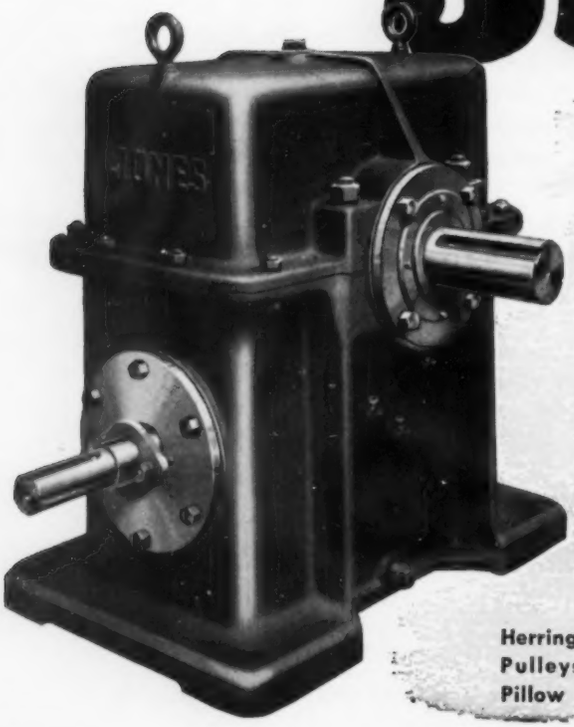
Reasons given for the successful performance of carbide bearings under extremely severe conditions include:

1. Ability of carbide metal to withstand extremely high unit pressures.
2. Ability of carbides to retain their inherent strength at high temperatures.
3. Ability of carbides to retain accuracy of fit without deformation under heavy loads.
4. The fact that carbides can be fitted with relative ease to extremely close running clearances. Such clearances remain low even under considerable increases in temperature.

Another advantage pointed out for carbide bearings is that they may make possible more compact designs of machines of all kinds. Their ability to take high unit pressures means that smaller bearings can be used, theoretically, to carry the same load.

In revealing some of the develop-

Jones



WORM GEAR SPEED REDUCERS

A right angle unit built for heavy duty performance in any industry. The worm can be above or below the gear. Shafts are single or double extended for coupling connections or chain or gear drives.

They are built in ratios from 4 to 1 to 90 to 1 and in capacities from ¼ to 100 H.P.

Bulletin No. 68 covers selection tables and dimensions.

W. A. JONES FOUNDRY & MACHINE CO.
4431 W. Roosevelt Rd., Chicago 24, Ill.

Since 1890 Jones In the Service of Industry

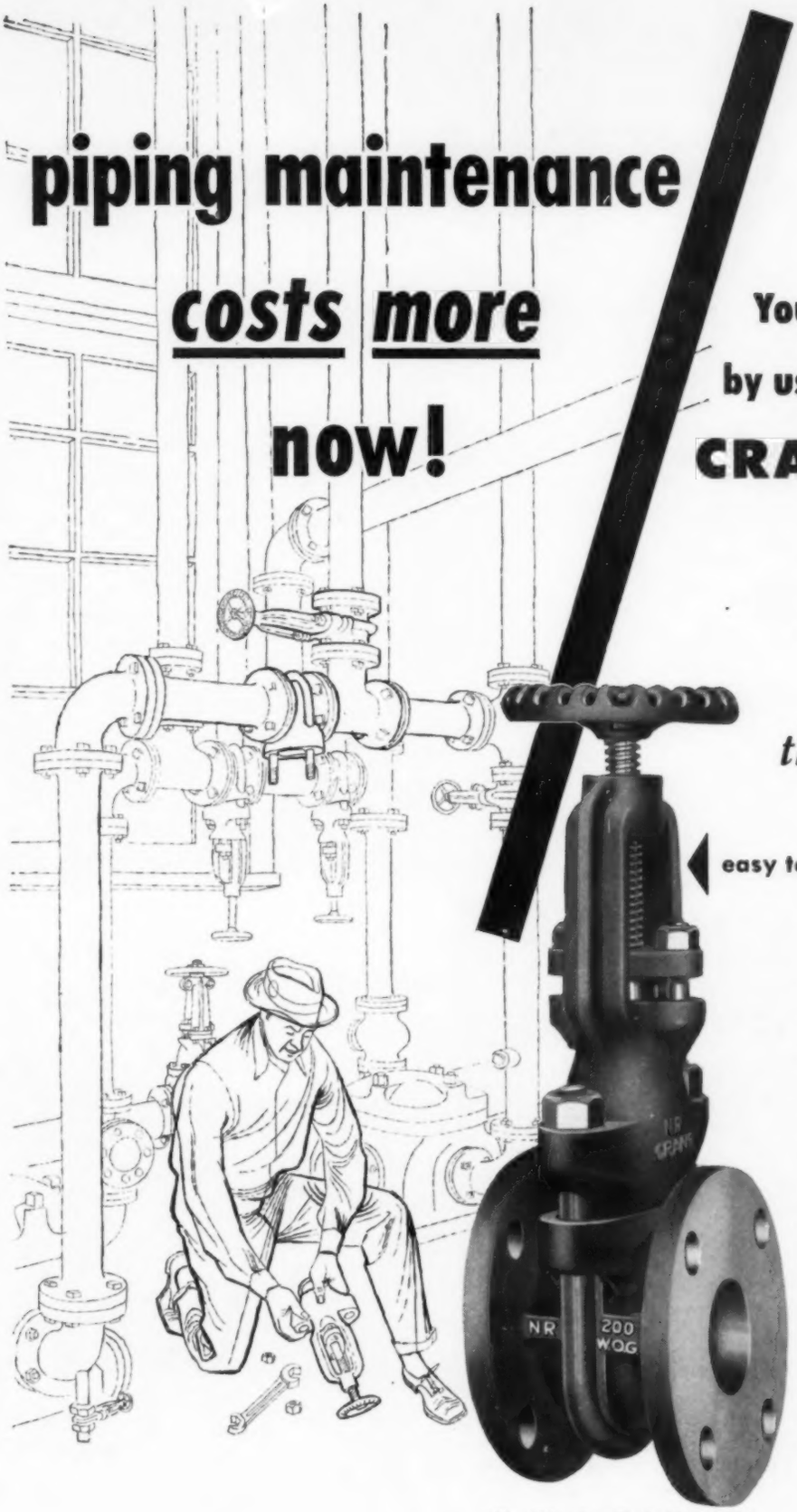
Herringbone — Worm — Spur — Gear Speed Reducers
Pulleys · Gears · V-Belt Sheaves · Anti-Friction
Pillow Blocks · Friction Clutches · Flexible Couplings

piping maintenance *costs more* now!

You spend less on it by using Dependable Quality

CRANE VALVES

. . . That's why more Crane Valves are used than any other make



No. 485½ Iron Body Clamp Gate

easy to open for inspection

It's no trick to dismantle this clamp gate valve for inspection, cleaning, or servicing. Just remove two nuts and lift out the complete bonnet and disc assembly. The body stays in the line Reassembling is just as easy. Repeated opening does not affect bonnet joint tightness or alignment.

A real time and labor saver on lines needing periodic cleanout, Crane Outside Screw and Yoke Clamp Gates are made in materials suited to a variety of services. Also Inside Screw with rising stem and Quick-Opening Patterns. Choice of flanged or screwed ends.

For complete valve suitability at lower ultimate cost, you're better off with Crane Valves. Ask your Crane Representative for demonstration.

CRANE CO.

General Offices:
836 S. Michigan Ave., Chicago 5, Ill.
Branches and Wholesalers Serving All Industrial Areas

VALVES • FITTINGS • PIPE • PLUMBING • HEATING

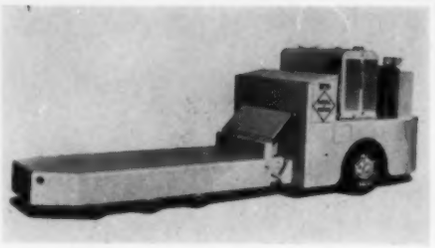
ment work to date on the use of carbide metals for bearings, Carboloy officials emphasized that these probably will not compete with existing bearing materials and designs where the latter can operate satisfactorily. Cost of materials is inevitably higher than for conventional bearing materials.

Among successful field installations of carbide bearings where other bearing materials have given trouble, have been special high speed grinder spindles operated under heavy loads; gasoline pump pivots where gasoline itself had to be used to lubricate the bearing; ways and slides of high precision high speed machine tools; and shaft support bearings on high speed precision balancing machines. The bearings have also been used, it is reported, in military applications at present on the classified list.

LOW LIFT TRUCK

▲ A new electric powered low lift platform truck is designed for the transport of loads weighing up to 40,000 lb and is one of the largest of its type available.

Built by Elwell-Parker Electric Co.,



the truck is designed to transport skids and skid boxes in plants where large heavy loads must be moved quickly and efficiently. Demand for larger and more rugged equipment has led to the development of this particular model.

The truck derives its "self-loading" feature from the fact that the load platform when positioned beneath the load can be raised hydraulically to lift the load off the floor for transport. It is not designed for tiering or stacking operations, its principal function being that of horizontal transportation.

Overall length of the truck is 193 in., width 56½ in. The platform measures 96 in. long by 41 in. wide by 17½ in. high in the lowered position, although these dimensions can be altered to suit requirements. Six inches of platform lift is available. Two 22 in. by 10 in. drive tires and six 15 in. by 10 in. trail tires are standard.

Several features have been incorporated in the truck's design to assure safety and maneuverability. The load platform nose is tapered to permit easy entry under skids. A rubber bumper on the rear end of the platform absorbs the shock of bumping the load when running under it, thus protecting the lift mechanism. A pressure relief valve in the hydraulic lift system provides overload protection. Power steer for all eight wheels makes maneuvering in close quarters a simple task in spite of the truck's size.

LADLE CAR

▲ Greater efficiency and economy in the production of small quantities of high alloy steels to accurate specifications have been achieved by means of a novel electronic weighing ladle car recently put in service at the Standard Steel Works Division of Baldwin-Lima-Hamilton Corp., Burnham, Pa.

Four SR-4 load cells of 20,000 lb capacity each have been built into the car as supports for the ladle. They are

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THERMIT

Cuts Cost of SLAG POT Maintenance

Reclaiming of burned-out slag pots by Thermit Welding saves one major steel producer $35,000 a year.

Here, and at other plants slag pots are repaired speedily by means of Thermit, saving time and work over other methods. In addition, because they match closely the composition and characteristics of the base metal, Thermit welds stand up under the severe service conditions of alternate heating and cooling to which slag pots are subject. Re-welding at the same location is unknown . . . much longer life for reclaimed pots is assured.

Many steel mill maintenance jobs are done more easily, more quickly and at lower cost with Thermit. Investigate! Write for complete information.

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Quick-As-Wink
AIR AND HYDRAULIC
Control Valves

No. 1551-N3
¾ Inch Neutral
Position 3-Way
Air Valve

HAND OPERATED Air Valves

Thousands of Uses Throughout Industry

● Universally used and endorsed. Valving mechanism has stainless steel body and push-pull rods, brass sleeves, self-sealing U-packers and many other refinements, all fully enclosed against dirt, assuring long efficient trouble-free operation. No metal to metal seating. ⅜" to 1½" sizes, 3-way and 4-way, neutral position and regular actions. Pipe header mounting plates furnished if desired. *Write for full details.*

THE HIGHER THE PRESSURE THE TIGHTER THE SEAL

Quick-As-Wink
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Hand, Foot, Cam, Pilot, Diaphragm and Solenoid Operated

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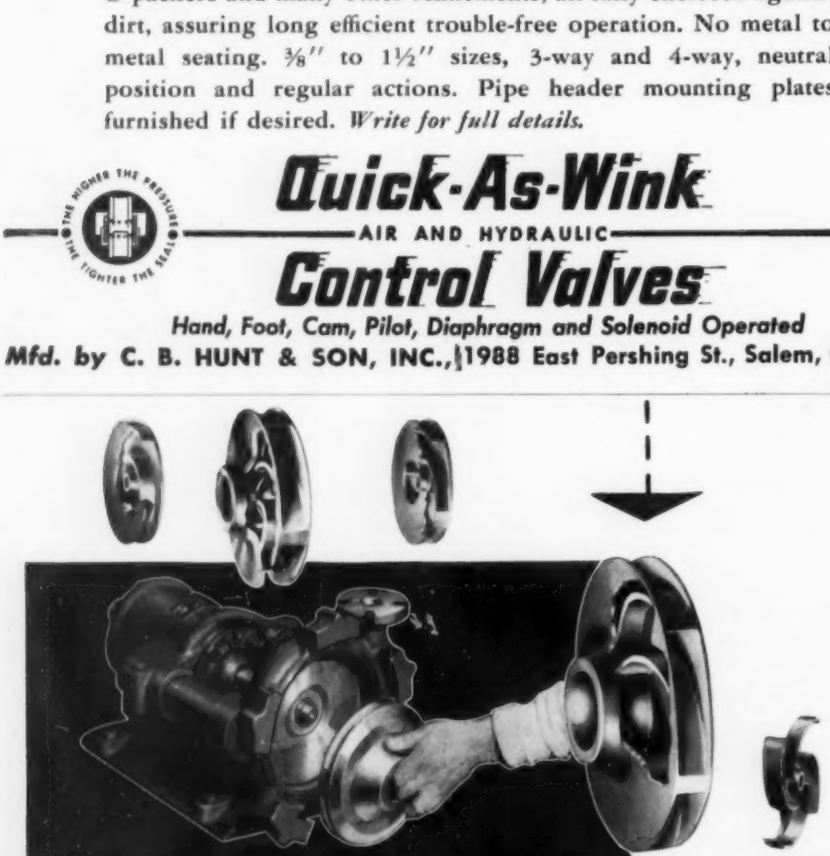
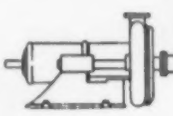


Will The Impeller Handle Your Job?

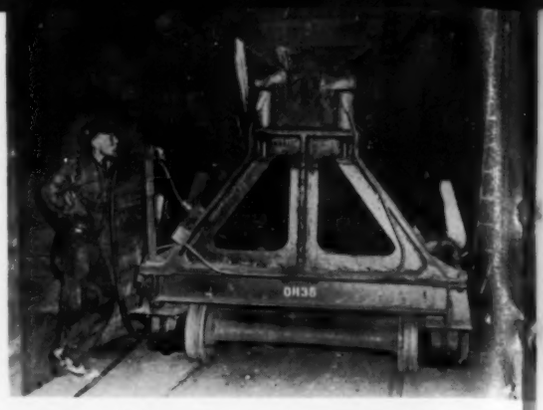
IT WILL if it's job-specified by Nagle . . . And at less cost per gallon or pound of material handled! Nagle impeller design holds sharp re-entrant angles to a minimum, cuts individual points of wear. You'll minimize stuffing box troubles, too, with relief holes that place the stuffing box in communication with lowest pressure area of the impeller. Face seals cut efficiency loss from internal leakage and protects the stuffing box from grit. This important attention to design details is found throughout every Nagle Pump—your assurance of longer pump service at less costs. If you have an abrasive or corrosive pumping problem, get the complete Nagle story!



Nagle Pumps INC.

INDUSTRIAL PUMPS FOR ABUSIVE APPLICATION

1263 CENTER AVENUE, CHICAGO HEIGHTS, ILLINOIS



connected through an armored cable to an indicator in the control pulpit in such a way as to sum up the total load in the ladle automatically on a dial indicator.

Accurately and quickly determined weight of molten metal in the ladle permits accurate and quick determination of the amount of alloy to be added to produce the exact chemical analysis required. It also continuously indicates how many ingot molds or molds for steel castings can be poured from the ladle. Both are advantageous in making steel and castings.

The load cells are based on the use of resistance wire strain gages bonded to a steel bar or column on which the load rests. These strain gages consist of very fine wire grids sealed to either a paper base or in a thin matrix of paper impregnated with bakelite. In use the gage is strained with the member to which it is bonded in proportion to the load, either in tension or compression. This strain changes the grid's electrical resistance which is measured by a Wheatstone bridge circuit and galvanometer or by electronic strain indicator, graphic recorder, or oscillograph. Both load cells and indicator are ruggedly built and have a high and permanent accuracy.

SOLVENT CLEANER

▲ Bunker C fuel oil storage tanks of all kinds tend to accumulate a particularly unpleasant deposit of muck and sludge which is also difficult to remove. There must be almost as many methods of tackling this removal job as there are operators of tank trucks, oil barges, tankers, etc., transporting Bunker C oil. In many cases, the equipment and the chemicals used for cleaning run to considerably high costs.

Not long ago a new method was tried out, based on the use of "Mag-

nusol HD"—an emulsifiable solvent cleaner, manufactured by the Magnus Chemical Co. This cleaner, mixed at about one part to eight of safety solvent has been used for many years on cleaning jobs involving the removal of heavy greasy dirt from all sorts of metal surfaces and it was thought that considerable savings in cleaning costs would be obtained if a technique could be worked out for using this cleaner on Bunker C sludge.

The work was carried out on oil barges, with multiple compartments, supplying fuel oil to river dredges. Previous cleaning practices had been to flood the compartments with distillate, allow it to soak in for an hour, then pump out the distillate and send a man, suitably equipped with safety suit, air supply and safety ropes into each compartment to flush out the softened residues. Results were better than no cleaning at all, but the sludge did not respond completely to the solvent action of the distillate and the actual cleaning job was far from adequate, particularly in view of the difficulty of effective removal of loosened deposits by a worker handicapped by the safety clothing, helmet, etc.

Quick-As-Wink AIR AND HYDRAULIC Control Valves

No. HH-551-N4 — ¾" 4-Way Neutral Position Hydraulic Valve

LEVER OPERATED Hydraulic Valve

For water or oil hydraulic systems to 5000 p. s. i.

● Unsurpassed for efficient trouble-free service controlling double acting hydraulic cylinders and other important high pressure hydraulic circuits. Positive, fast acting. All parts are in pressure balance, eliminating any tendency to creep or crawl. Machined steel housing, chrome plated and polished stainless steel plungers. Self sealing U-packers. Metal valving rings take the impingement of the liquid, preventing wear on the packings. ½" to 1½" sizes. Available also in pilot operated designs up to 4". *Write for full details.*

THE HIGHER THE PRESSURE THE TIGHTER THE SEAL

Quick-As-Wink AIR AND HYDRAULIC **Control Valves**

Hand, Foot, Cam, Pilot, Diaphragm and Solenoid Operated

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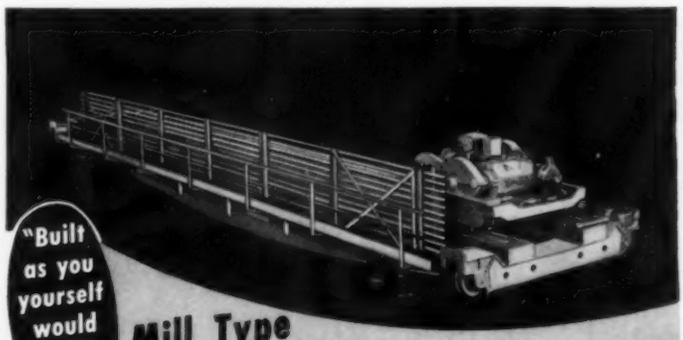

"Built as you yourself would build them"

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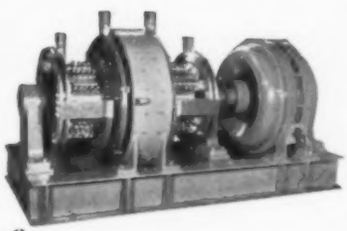

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The solvent cleaner was mixed with distillate in the proportion of one part Magnusol to 10 parts distillate. This mixture was sprayed through a large spray gun by a man clothed in safety suit, etc., while inside the tank. By the time he covered all surfaces inside the tank with this mixture, the surfaces first treated were ready to be flushed off. The muck and sludge were loosened from their bond to the metal surface of the tank and were readily washed off, together with the emulsion formed by the Magnusol mix and water, when the operator returned to his starting point and flushed off all areas with water under pressure.

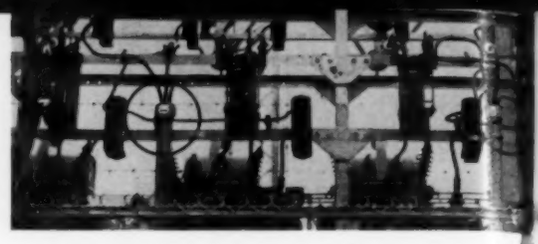
The first trial proved the case thoroughly. All residues were removed completely by the one sequence of spraying on the mix and flushing off. Tanks were cleaned right down to the bare metal and no residues remained. This technique has been followed since the time of the original test and it has been found that on the average, one man can thoroughly clean out a compartment in less than a half hour.

The technique will vary according to the kind and size of tank to be cleaned, but the essential feature of the method is thorough spraying with the mixture of the solvent cleaner and distillate, safety solvent, mineral spirits, or the like on all surfaces of the tank. followed by flushing off the surfaces with water. The entire operation is carried out at normal temperatures and there is no possibility of attack on the metal. On tanks too small for a man to enter, the surfaces can be readily reached by a man using a spray gun from the outside.

The main point is that this method is simple and economical—much more so than the other methods of tackling this formerly difficult cleaning job.

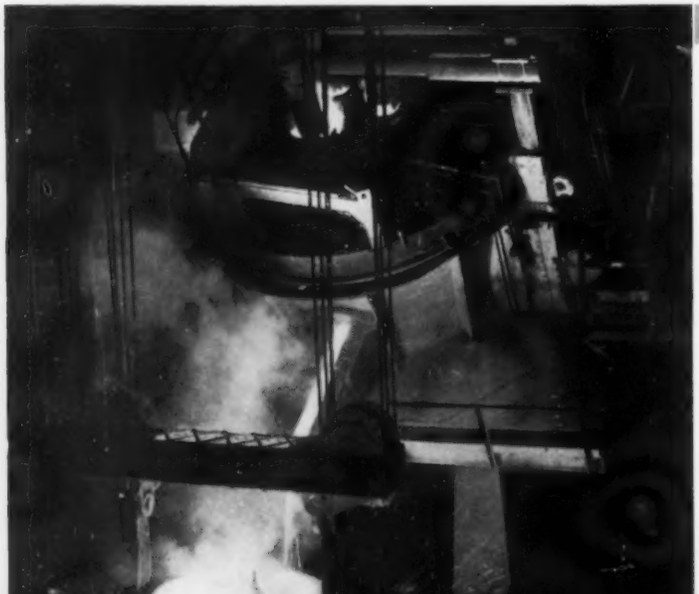
CABLE SUPPORTS

▲ "Wedgelock Supports," the new type of cable support and conduit seal are now on the job all over the country. Steel mill men and contractors report that these supports are filling definite needs for supports which provide for extensions and for horizontal installations. The dual-purpose support and seal is shown in the illustration of an installation at a large utility company. Here, these



supports are not only supporting the cables on this 23,000 volt structure, but are also compound-filled to prevent water following down the cables into the conduits. For outdoor use such as indicated, the fitting is equipped with an aluminum alloy body which will not rust and, of course, for single-phase circuits, is non-magnetic. The cables are effectively gripped with time-proven "Sali" wedges.

This fitting is one of a family each effectively doing a different type of operation involving the supporting or gripping of cables. All have wedge inserts of a laminated phenolic material of extremely high tensile, flexural and dielectric strengths which will withstand the most rugged use. The inserts are tapered to lock themselves more tightly into place as strain increases. Descriptive literature on other members of this "Wedgelock" support family is offered by the manufacturer, Adalet Manufacturing Co.



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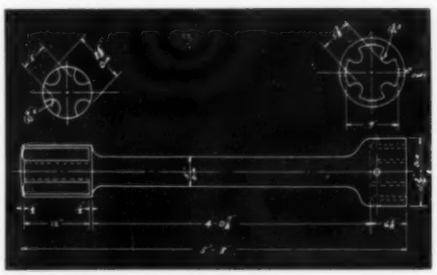
UNITED STATES STEEL

SPINDLE-COUPLING BOX

▲ On a certain rolling mill stand of a major steel producer the coupling boxes and spindles were wearing out at the rate of one box and one spindle each month. To replace them a combination spindle and coupling box unit was cast by the Stroh Process, an exclusive manufacturing process of Stroh Process Steel Co. This unit gave six months of service on the same rolling mill stand, resulting in a cash saving of $700 for the period. The steel producer had paid $648 for spindles and $192 for coupling boxes, or a total of $840 for replacement equipment during the previous six month period. The single combination Stroh unit cost $140.



The process, the exclusive casting method by which the combination unit was produced, involves the casting of a tough, austenitic steel alloy on a base of plain carbon steel. Since the depth, thickness, degree of hardness and location of the alloy can be controlled exactly, it was applied only to the spindle wabblers and the pods of the coupling-box end. In effect, this provided a piece of equipment with the wearing characteristics of a high grade steel casting at a cost only slightly more than that of a plain carbon steel casting.

INTERCOM SYSTEM

▲ A fleet of radio-equipped plant vehicles, controlled from a central dispatcher, form the backbone of materials handling equipment at the Timken Roller Bearing Co., Steel and Tube Division Plant in Canton, Ohio.

Twenty-four mobile units, including locomotive cranes, a jeep, fork trucks, and nine straddle-trucks are equipped with Motorola FM 2-way radios in order to reduce movement time, eliminate dead-heading, improve control, and increase overall operating efficiency.

The fleet of straddle-trucks haul steel billets from the mill to storage points in the yards around the plant and return them when needed to the mills for further processing or shipping. There are a number of outdoor storage yards at distances from a few hundred feet to half a mile from the mills.

Before the installation of 2-way radio, one man was assigned the job of just chasing down plant vehicles and giving the drivers orders from the dispatcher. There was no other way to contact the vehicle operators. Radio was initially installed because some new means of communications was a necessity.

The dispatcher now has full authority to direct mobile equipment by use of the Motorola 2-way radio equipment. He controls operations based on requests for movements telephoned to him by production control people in different parts of the plant.

In order to make sure the operations are carried out with maximum efficiency, a work recorder is installed on each radio-equipped vehicle. This

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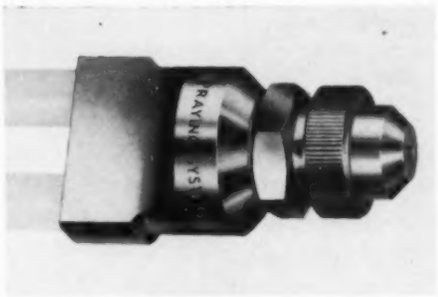
recorder, combined with performance records, has proven the greatly increased efficiency resulting from the addition of FM 2-way radio control.

ATOMIZING NOZZLE

▲ Now for the first time users of pneumatic atomizing nozzles will be able to obtain nozzles of this type where the piping connected to the nozzle will be in line with the direction of spray. This new design, the ⅛ JBC pneumatic atomizing nozzle, is of considerable importance in applications where space is limited and where the nozzle must be mounted in a projected position in relation to the part or material to be sprayed.

Formerly all pneumatic atomizing nozzles were designed with inlets for air and liquid pipe connections in opposed positions at right angles to the line of spray. In many installations the air and liquid supply lines for this type of nozzle caused serious mounting difficulties. With the new ⅛ nozzles these problems are completely eliminated. It has also been found that the ⅛ pneumatic atomizing nozzle is ideal for portable operation, since the two pipes running parallel from in back of the nozzle can be used as a handle for holding. Shut-off valves can be mounted on each of the pipes, if desired. The nozzles can be furnished made of either brass or stainless steel.



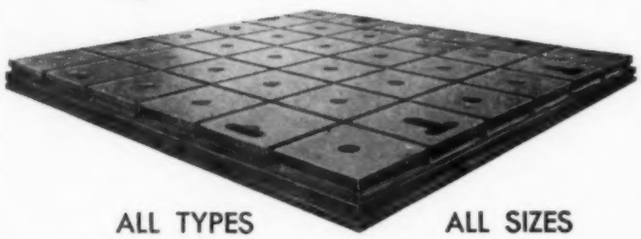
The ⅛ pneumatic atomizing nozzle is designed for use with all standard Spraying Systems Co. fluid and air nozzle assemblies . . . to meet a wide range of requirements in spray type, size and volume. Assemblies available include both pressure and siphon set-ups, for producing round, flat, and wide-angle round sprays.

OIL PRESSURE LOADER

▲ Askania Regulator Co. has developed a panel-mounted oil pressure loader for manually controlling oil pressure to devices normally operated automatically.

Both automatically controlled and manually controlled pressures are indicated on gages, so that the operator can avoid discontinuity by matching the two pressures before switching from one mode of control to the other. A three-way valve selects the mode of control.

Hyde Park



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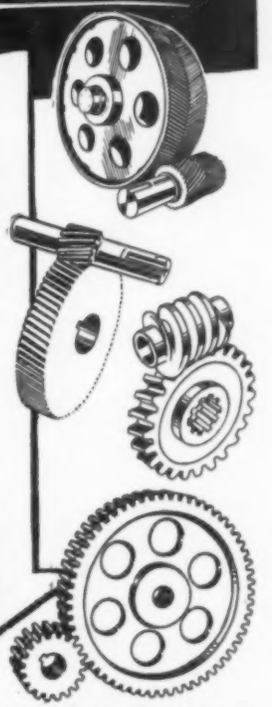

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AMPLIFIER CONTROL

▲ Offering precise control of speed with no maintenance problems, is the new "Regutron" magnetic amplifier control. This new controller is used with the Electric Machinery Mfg. Co. adjustable-speed magnetic drive, an electromagnetic torque transmitting device which gives variable speed output when used in combination with a constant speed motor.

This simplified magnetic amplifier control eliminates all the complicated electronic circuits of the previous electronic type amplifiers. A simple saturable core reactor amplifier system using non-moving parts accomplishes the precise, stepless control of speed to within ± 0.5 per cent of speed called for. This hairline sensitivity is obtained through a current amplification ratio of approximately 20,000 to 1.

All components in this new control are reliable, time-proven devices, and conservatively rated parts should last for years with little change in characteristics.

Adjustable-speed magnetic drives are built in ratings of 25 hp and higher in the usual motor speeds. They are popularly applied to loads such as fans, centrifugal pumps, and centrifugal compressors.

Components of this new control should last for years with little change in characteristics.

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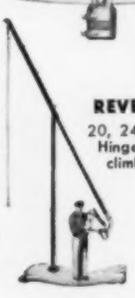

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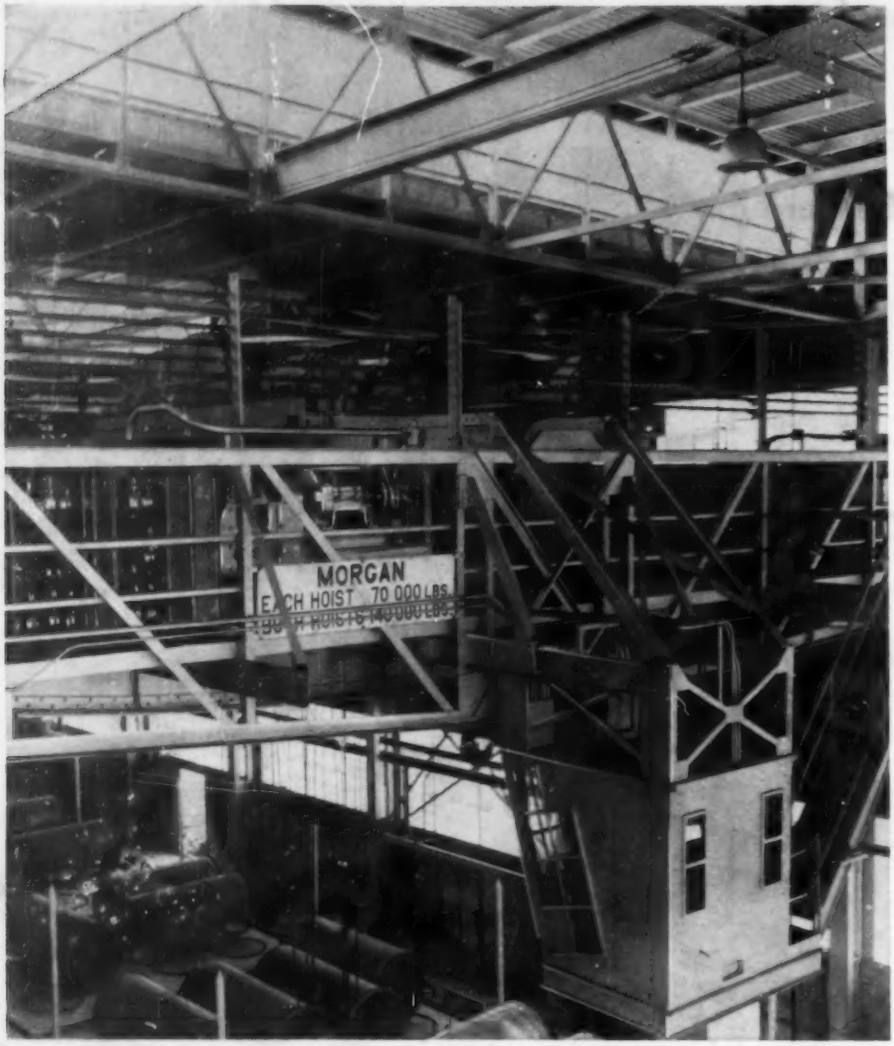
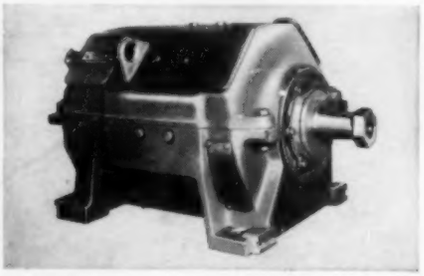
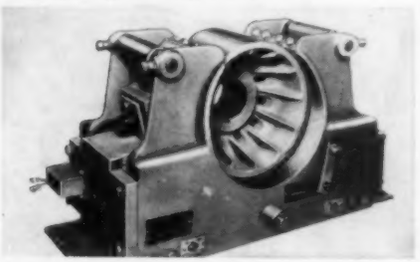


This 70-ton crane in a large steel mill—with a double hoist each rated 35 tons—is one of seven, all equipped with G-E crane drives, including Type MD-600 motors and hoist, bridge and trolley controls.

G-E crane control provides superior lowering performance for any hook load.



G-E MD-600 crane motors offer improved ventilation and maintenance ease.



G-E fast acting magnetic brake permits easy adjustment, requires less maintenance.

New control protects against overloads!

G-E hoist control panel solves tough motor maintenance problem; leads to choice of seven new G-E crane drives in large steel plant.

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D-C CRANE DRIVES

Here's the kind of success story that's making General Electric crane control a heavy steel-mill favorite. In the box annealing building at this large mill, a 10-ton auxiliary hook on a mill crane was handling stacks of steel sheets to be put into annealing furnaces. Because the crane was frequently overloaded, two to four motor breakdowns a year had occurred over an eight-year period.

A G-E hoist control panel was installed in place of the previous magnetic control, providing safe and stable full-speed lowering operation for heavy overloads. Result: Motor breakdowns were cut to zero during the next 20-month period before the crane was retired from this severe duty. Furthermore, motor maintenance had been reduced by the lower commutating peaks and improved automatic deceleration. So impressed were the mill's operators by this outstanding performance that they selected G-E crane control, plus G-E MD-600 crane motors, for seven new crane installations (one shown above).

Is *yours* a tough crane drive problem? General Electric—with over 40 years of experience in working with crane builders—can help you solve it. Ask your G-E steel-mill specialist about it; meanwhile send for Bulletin GEA-5408 on G-E d-c crane drives. *General Electric Company, Schenectady 5, N. Y.*

GENERAL ELECTRIC

659-83

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Book Reviews . . .

▲ U. S. Steel's "The Making, Shaping and Treating of Steel," sixth edition covers in a completely revised book the scientific advances in the steel industry during the last ten years. In addition to new information, descriptions of standard processes have been revised or rewritten to bring them up to date.

The book has been under preparation for more than two years, and is based on the original text by J. M. Camp and C. B. Francis.

Technological progress in the last decade covers new steels, faster steelmaking methods, and a revision of steel compositions to conserve alloying elements in a new national emergency.

Experts and authorities in each steelmaking field prepared the new book. It is presented in 38 chapters, subdivided into sections. Each chapter and section is made as nearly independent of the others as possible. With more than 23,000 listings, the index of the sixth edition is cross-referenced and covers 148 pages of the 1584-page book. Most of the 713 illustrations are new and were selected to provide as much clarity and detail as possible.

The chapter which is probably most representative of the tremendous technological strides taken by the industry in the past ten years is that covering the principles of heat treatment of steel; this includes the work of Bain, Davenport, Grossmann and others who have helped to reduce the art of heat treatment to a science, with changes in steel structure predictable by comparatively simple diagrams. Similarly, understanding of thermodynamics, heat flow and ceramics has been broadened by Dr. J. B. Austin and his associates at U. S. Steel's Kearny Research Laboratory. This and similar broadening of knowledge made it necessary to revise large sections of the book, including those parts devoted to discussion of drives and power requirements in steel mills, the theory of corrosion, protective coatings, and new methods for making tubular products. The raw material sections have been extended to include discussions of the desulphurization of coal and the beneficiation of ores.

The following subjects have been completely revised and expanded to cover new methods and techniques developed in the past decade: Fundamental principles of chemistry and physics; refractories; manufacture of pig iron; the bessemer process; the open hearth process; manufacture of steel in electric furnaces; steel and iron castings; merchant bar production; manufacture of hot strip mill products; manufacture of cold-reduced, flat-rolled products; manufacture of tin plate, with an entire new section of the electrolytic process; metallurgical aspects of tin plate; principles of heat treatment of steel; all chapters on various grades of steel; mechanical testing; and gage numbers.

The sixth edition of "The Making, Shaping and Treating of Steel" is published on a non-profit basis. It is priced at $7.50, with a reduction to $5.00 for schools and colleges. Orders for the book will be received by the Treasurer, United States Steel Co., 525 William Penn Place, Pittsburgh 30, Pa.

▲ A statistical study of the production, consumption and uses of fuels and electric energy in the United States in three representative years of the last three decades has been completed by the Bureau of Mines.

Assembling in one comprehensive report the historical statistical data scattered through many publications, the Bureau's study is believed to fill an important need in planning future energy requirements of the United States. The historical statistics showing production and consumption of all energy are given on a Btu basis.

Three census years—1929, 1939, 1947—are used as a basis for compiling the information in the report. The year 1947 was selected because 1947 was the most recent year for which census figures are available showing fuel consumption by each of the manufacturing industries.

Coal, lignite, petroleum, electric energy, natural gas, wood, and various derivatives of these basic fuels are covered in the report which consists largely of detailed tables of data and accompanying interpretative text.

A free copy of Report of Investigations 4805, "The Production, Consumption, and Use of Fuels and Electric Energy in the United States in 1929, 1939, and 1947," may be obtained by writing to the Publications Distribution Section, Bureau of Mines, 4800 Forbes Street, Pittsburgh 13, Pa. The publication should be identified by name and number.

▲ ASTM Standards on Petroleum Products and Lubricants (with Related Information) brings together in compact, readily usable form, most of the ASTM standards, test methods, and specifications widely used in this field. (The tests for knock rating of engine fuels and certain standards for measuring and sampling petroleum are issued in special manuals and not included in this compilation.)

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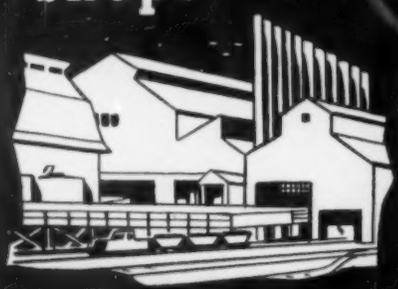
in the majority of open hearth shops



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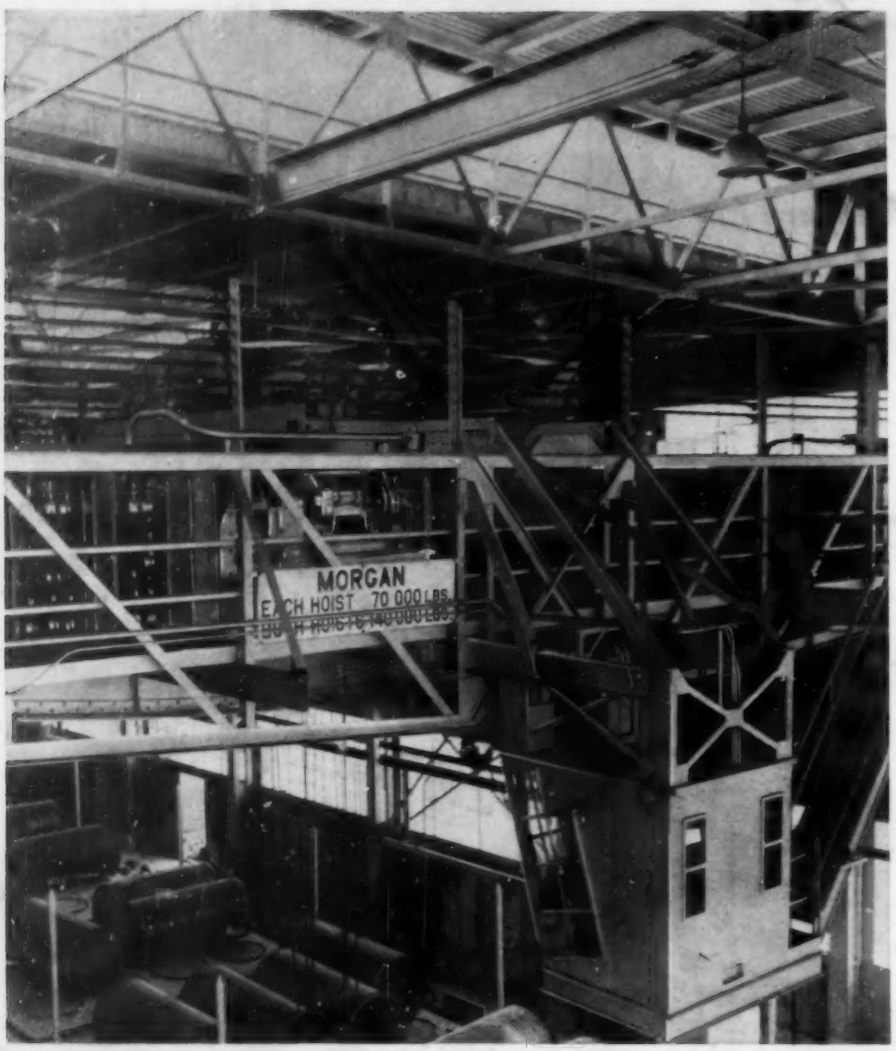

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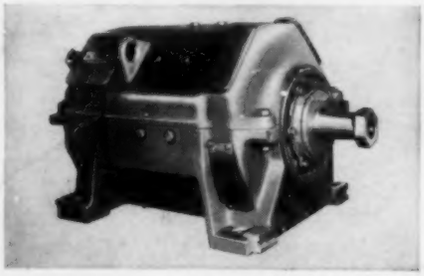

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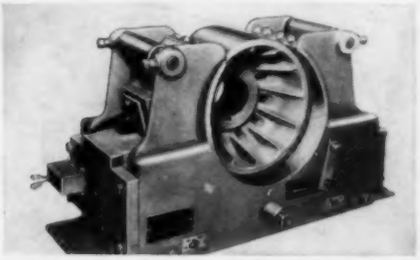

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